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Technical Report

No. 13236

ELECTRIC DRIVE STUDY
VOLUME 2 OF 2

CONTRACT NUMBER DAAE07-84-C-R017

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Warren, Michigan 48397-5000

NOTICES

APPENDIX A

TECHNOLOGY SURVEY SUMMARY

Appendix A Technology Survey Summary

A.1 Technology Report

As required by contract DAAE07-84-C-R017, a comprehensive technology survey report was prepared between February and August 1984. This report details the approach and results of a survey of motors, solid-state controls, alternator/generators, and servo components which were potential candidates for the advanced electric drive study. In addition, solid-state components and various materials such as advanced magnetics were included in the survey. The survey report was approved in January 1985.

A.2 Survey Update

The motor tree at Figure A.2-1 formed the basis for the motor survey. Results of the survey effort for motor selection is shown in Figure A.2-2. This selection process was the result of an extensive matrix/tradeoff analysis and was initially used in early concept development. As the concepts were refined, performance vehicle factors became an influence in the motor component selection. The result of the influence was the selection of the Homopolar motor for the DC system and the high frequency induction motor for the AC system. The selection of these motors for the Configuration I analysis dictated the additional system components such as the motor power conditioners/controllers and the alternator/generators.

Figure A.2-3 compares the selected motors with respect to operational and characteristic attributes. The hybrid permanent magnet (PM) "brushless" motor is included in the comparison to indicate the effect of relative complexity introduced by the total PM motor/power conditioner system. In this comparison, the DC and AC motors operate independent of an external power conditioner.

It is apparent for this update comparison that no clear "best" motor component selection is possible since each different type has certain advantages not shared by the other.

Motor power controllers/conditioners are compared in Figure A.2-4. In this comparison, the DC system appears to have some advantage due to the inherent gain of the DC motor and thus the lack of any power semiconductors. The power controllers/conditioners for the AC and hybrid motors are all DC to AC inverter systems and are designed around large power semiconductors.

A comparison of selected alternator and generator technologies is shown in figure A.2-5. In this comparison, the AC alternator candidate is a standard aircraft design with an operating frequency of 400 Hz.

The present status of candidate power semiconductors is shown in Figure A.2-6. As expected, the semiconductor industry continues

to work on improvements to increase the voltage and current capability and reduce the turn-on/turn-off time. No significant technology break-through's are presently foreseen in this area which would produce a radical improvement for use in high power drive systems.

It is unfortunate that the majority of high power semiconductor research is being done outside the United States.

Figure A.2-7 documents the trend in magnetic materials used in permanent magnet motors. With the introduction of Neodymium/Iron/Boron, an alternative is not available to replace, Smarium-Cobalt magnets for high energy density applications. Neodymium/Iron/Boron will continue to be improved and should be seen in products within the next 3 to 5 years. The use of this new material should yield a significant weight reduction and associated cost reduction in motors and generators.

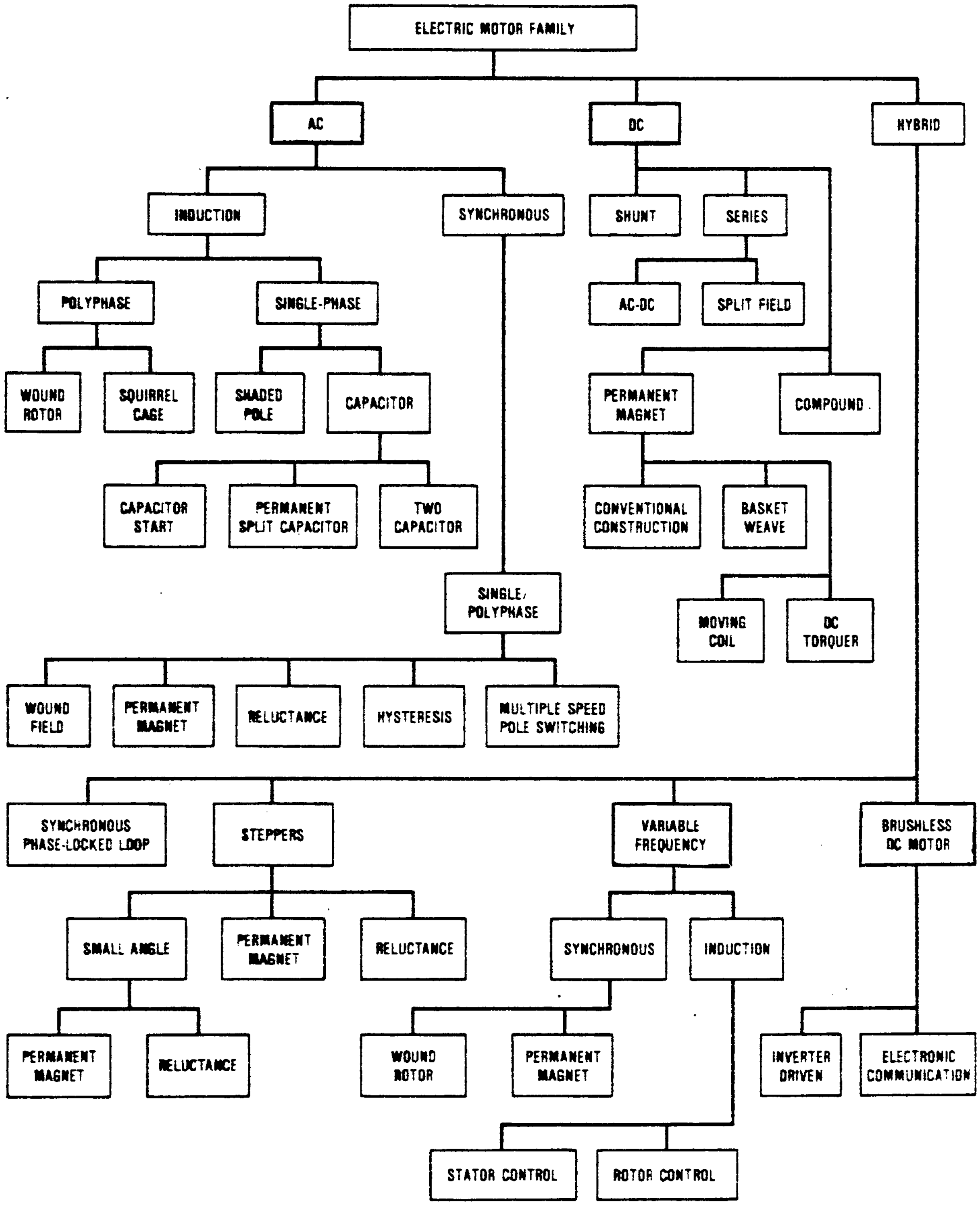

Figure A.2-1 Electric Motor Technology Tree

Motor Technology Screen

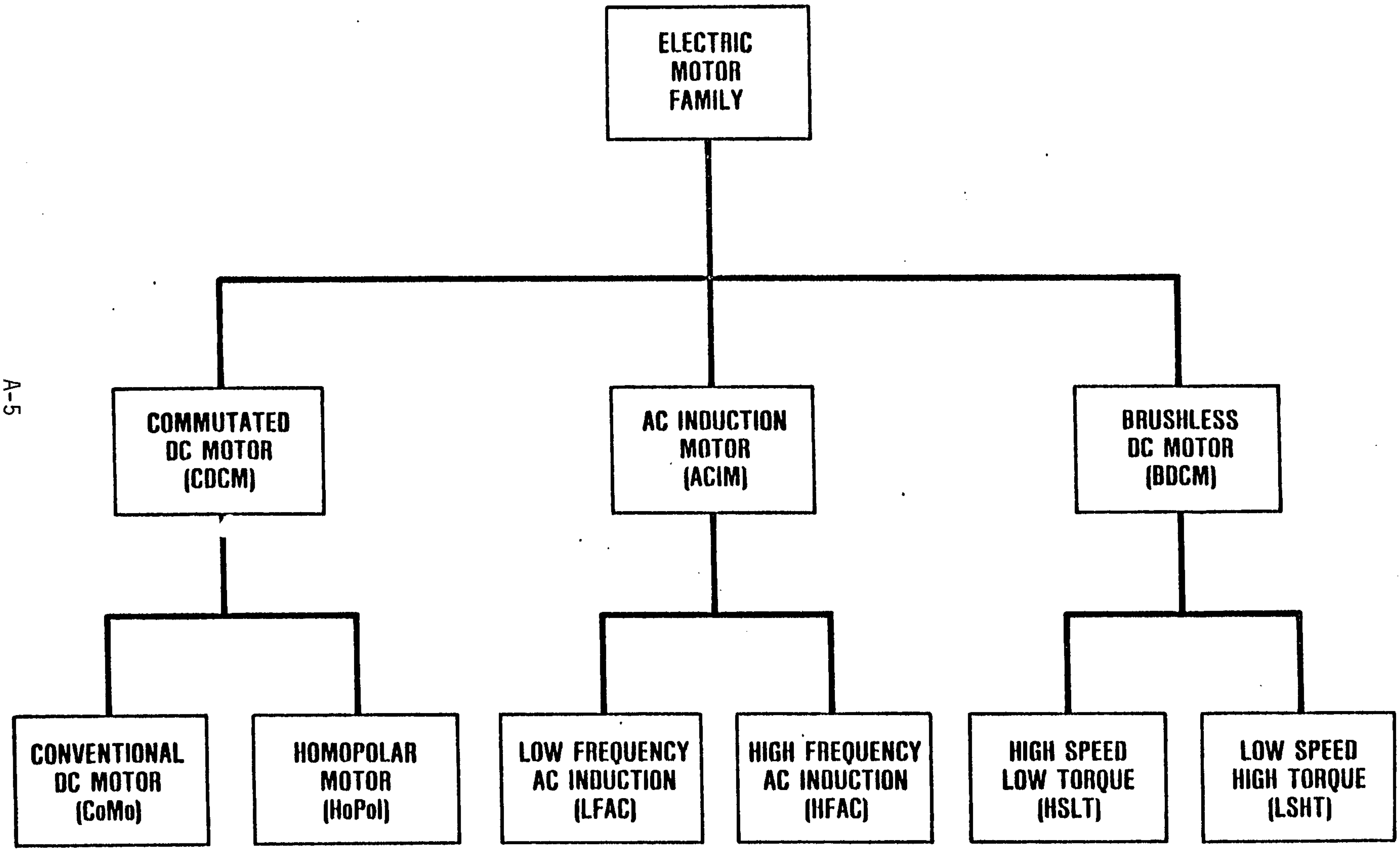

Figure A.2-2 Initial Motor Candidates

FMC

ELECTRICAL SYSTEM COMPONENTS

- MOTORS -

ATTRIBUTES	DC (HOMOPOLAR)	AC (INDUCTION)	HYBRID (PERM. MAG.)
PEAK EFFICIENCY	92.8%	95%	95%
SYSTEM VOLTAGE	18-32	200-600	400-600
MAJOR LOSSES	BRUSH I^2R	ROTOR I^2R	STATOR I^2R
OVERLOAD RANGE	14.37/1	14/1	6.4/1
PEAK TORQUE	>1000 LB FT	>1000 LB FT	MAGNET LIMIT
SPEED RANGE	0-15,000	0-15,000	0-15,000
ROTOR INERTIA	LOW	MODERATE	MODERATE
PACKAGING	GOOD	GOOD	GOOD
THERMAL CONTROL	FLOOD COOL	FLOOD COOL	FLOOD COOL
SHOCK/VIBRATION	GOOD	GOOD	MODERATE
RELIABILITY	GOOD	EXCELLENT	MODERATE
TECHNICAL RISK	MODERATE	LOW	HIGH
RELATIVE COST	1.0	1.0	2.0

Figure A.2-3 Selected Motor Candidates

FMC

ELECTRICAL SYSTEM COMPONENTS

- MOTOR CONTROLLERS -

ATTRIBUTES	DC (HOMOPOLAR)	AC (INDUCTION)	HYBRID (PERM. MAG.)
EFFICIENCY	> 95%	>95%	>95%
CONTROL MODE	VF-PWM	VFAC	VF-PWM
CONTROL RANGE	100%	100%	98%
CONTROL POWER RATIO	2.7%	100%	100%
COMPLEXITY	LOW	MODERATE	HIGH
RELIABILITY	GOOD	MODERATE	MODERATE
POWER SEMICONDUCTORS	NONE	6/3 PHASE	6/3 PHASE
SEMICONDUCTOR LOSSES	LOW	MODERATE	MODERATE
REGENERATIVE	YES	YES	YES
EMI/RFI	LOW	MODERATE	HIGH

Figure A.2-4 Selected Motor Controllers

FMC

ELECTRICAL SYSTEM COMPONENTS

- ALTERNATORS/GENERATORS -

CHARACTERISTICS	AC ALTERNATOR (400Hz)	DC GENERATOR (HOPOL)
EFFICIENCY	HIGH - >93%	HIGH - >93%
OPERATING SPEED	8000-12000 RPM	10000-14000 RPM
VOLTAGE CONVERSION	RECTIFIER	DIRECT
FIELD CONTROL	YES	YES
REGULATION	GOOD	GOOD
THERMAL CONTROL	SPRAY OIL	FLOOD COOL
REGENERATION	INVERTER/RECTIFIER	BI-DIRECTIONAL
POWER/WEIGHT RATIO	EXCELLENT	GOOD
POWER/VOLUME RATIO	GOOD	GOOD

Figure A.2-5 Selected Alternators/Generators

FMC

ELECTRICAL SYSTEM COMPONENTS

- SEMICONDUCTORS -

PRESENT STATUS

SILICON CONTROLLED RECTIFIER (SCR) - INTEGRATED TRANSISTOR GATE

* FOCUS ON HIGH VOLTAGE/HIGH CURRENT - UTILITY APPLICATIONS

GATE CONTROLLED RECTIFIER (GTO) - INTEGRATED TRANSISTOR GATE

* FOCUS ON IMPROVEMENT IN TURN ON/TURN OFF GAIN

BIPOLAR JUNCTION TRANSISTOR (BJT) - INTEGRATED TRANSISTOR BASE

* FOCUS ON IMPROVING GAIN AT HIGH CURRENTS/HIGH VOLTAGE

FIELD EFFECT TRANSISTOR (FET) - MATERIALS IMPROVEMENT -

* FOCUS ON REDUCING OHMIC LOSS AND POWER DISSIPATION

PRESENT TREND

MAJOR EMPHASIS IN POWER SEMICONDUCTORS CONTINUES TO BE IN JAPAN. INTRODUCED 1500 VOLT/350 AMP DEVICE.

Figure A.2-6 Power Semiconductors Status

FMC

ELECTRICAL SYSTEM COMPONENTS

- MAGNETIC MATERIALS -

MATERIAL	YEAR	ENERGY PRODUCT	IMPACT
SMARIUM COBALT 5	1970	$16-18 \times 10^6$	10-30% REDUCTION
SMARIUM COBALT 217	1978	$28-32 \times 10^6$	PRESENT PRODUCTS
NEODYMIUM-IRON-BORON	1984	$45-60 \times 10^6$	NEW

TREND

PREDUCT 3-5 YEARS FOR NEODYMIUM-IRON TO BE PROMINENT IN MARKET. SHOWS GOOD PROMISE OF REDUCING COST AND USE OF CRITICAL MATERIALS. MAJOR PROBLEM WILL BE PROPER THERMAL CONTROL

Figure A.2-7 Magnetic Material Trends

APPENDIX B

DATA GENERATION REPORTS

B.1 Analytical Methods Used For Performance Analysis

Our performance analysis used validated computer programs to evaluate all significant factors when preparing performance predictions. Existing programs were adapted to meet the specific analysis requirements of this project. These existing programs were based on the principles of SAE recommended practice J688, with appropriate modifications for tracked vehicles. The resulting programs produced the following specified data:

1. Tractive effort vs. speed

2. Acceleration

3. Startability on grades

4. Maximum speed on grades

5. Minimum turn radius vs. speed

The programs were integrated on a conservation of energy basis:

[1] (Input HP - Loss HP) * (Drive efficiency) = Power output

The input horsepower is the engine horsepower at its operating speed less the appropriate deductions for altitude, temperature, air cleaner, muffler and grills. The loss horsepower includes such items as cooling fan, auxiliary generator, hydraulic pumps and similar parasitic loads. The drive efficiency is measured from engine flywheel to sprocket to fairly assess added losses due to speed up transfer cases to drive high speed generators or high ratio final drives to match high speed motors. The power output to rolling resistance, windage (air resistance), grade resistance and turning losses.

The power budget for the input horsepower is as follows:

1.	Rated engine horsepower	500.0
2.	Conditions (standard)	- 0.0
3.	Air cleaner & muffler	- 5.0
	Net input horsepower---------------	495.0

The power budget for parasitic losses is as follows:

1.	Net input horsepower	495.0
2.	Fan (sized for ballistic grills)	-46.2
3.	Auxiliary generator	- 5.8
4.	Hydraulic pump	- 3.0
	Net input horsepower	440.0

The drive efficiency is determined as follows:

1. Generator (or alternator) efficiency is estimated from data for similar items and from manufacturer's estimates. Since these efficiencies are essentially constant at loads over 25% of rating, and the analysis is for full power, a fixed efficiency value is used for all calculations for any given generator type.

2. Power conditioning and control equipment, like the generator, have essentially constant efficiency under normal loads and are therefore also held at a fixed value that is based on data for similar items and on manufacturer's estimates.

3. Motor efficiencies under normal loads are primarily a function of armature speed (RPM). Curve fits have been made with correlation coefficients of at least 0.99 and the resulting equations are used to calculate the efficiency of each motor at each operating point of every operating condition. This detailed approach becomes particularly significant in turns, when each motor has its own individual efficiency at each operating point. Refer to Section 5.1.4.6, Figure 5.1.4.6-B for an example of the differentiations between systems that result from this precise analysis.

4. Power output must equal the sum rolling resistance, wind resistance, grade resistance and turn losses so steady state operation can exist. These values are determined as follows:

o Rolling resistance:

Rolling resistance has been based on a value of 100 pounds per ton, which has been found to be a reasonable value for tracked vehicles on smooth, hard surfaces.

[2] RR = GVW / 2000 * Cr

Where:

RR = Rolling resistance in pounds
GVW = Gross veicle weight
Cr = Rolling resistance coefficient
(100 pounds per ton for this study)

o Wind resistance:

Wind resistance has been based on the specified frontal area, a drag coefficient (Cd) of 1.0, vehicle speed in MPH, and a coefficient of 1/391 for standard conditions (ref. Fluid Dynamic Drag, Dr.-Ing. Sighard Hoerner).

These values are used as follows:

[3] $$Rw = Af * Cd * (MPH ^ 2) / 391$$

Where:

Af = Frontal area in square feet
Cd = Drag coefficient (estimated at 1.0)
MPH = Vehicle speed, miles per hour

o Grade resistance:

Grade resistance is calculated from the basic geometric considerations. The equation used is:

[4] $$Rg = GVW * Sin (Atn (GR / 100)$$

Where:

Rg = Grade resistance in pounds
GVW = Gross vehicle weight in pounds
GR = Grade in per cent

o Turning losses:

Turning losses consist of power dissipated in scrubbing the tracks around a turn and regeneration losses due to inefficiencies in the regeneration system. These values of scrub horsepower and regenerative horsepower are quantified using methods originated by Merritt and updated in TACOM Technical Report 10969,"Investigation of the Factors Involved in Steering Tracklaying Vehicles". As the method is complex, reference to this report is recommended for those who want the details of the analytical method. The "Scrub Horsepower" is applied directly as a loss. The regeneration loss is found by first determining regeneration efficiency from motor speed and controller efficiency, as is described for drive efficiency. The Transfer Horsepower is then multiplied by the regeneration efficiency to determine the losses due to regeneration.

The above analytical methods have been integrated into a series of programs to solve for specific operating conditions such as tractive effort vs. speed, speed vs. time, speed vs. distance, maximum speed vs. grade, and minimum turning radius vs. speed. In each case the complexity of the calculation necessitates an iterative solution. The appropriate variable is increased until a power balance is reached and the requirements of equation [1] above are met. The performance and load values for that

particular operating point are then printed as required by the contract.

B.2 Data Table Description

The tables in Appendix B provide detailed quantification of the results discussed in the report and the power train load and speed data required by the contract. The following tables tabulate the performance analysis data used in this report. Tables are organized to facilitate comparative analysis by grouping by type of performance, and presenting data for all of the various vehicle and drive types within that group. The data table groups are:

A. Speed vs. grade and tractive effort

B. Acceleration

C. Sprocket and motor speeds and loads for maximum turn condition

D. Gear speeds and loads at maximum turn condition

E. Gear speeds and loads at maximum tractive effort condition

Within these groups are performance results for the following vehicle and drive types:

1. 19.5 ton, Configuration I, AC induction motor drive system

2. 19.5 ton, Configuration II. AC induction motor system

3. 19.5 ton, Configuration I, DC homopolar system

4. 40 ton, Configuration I, AC induction motor drive system

5. 40 ton, Configuration II, AC induction motor drive system

6. 40 ton, Configuration I, DC homopolar system

Tables can be easily located by combining the heading letters and numbers from the above listings. As an example, acceleration data for the 19.5 ton, Configuration II, AC induction system is in table B-2.

B.2.A Speed Vs Grade And Tractive Effort Tables

The following tables provide speed vs. grade data plus corresponding sprocket speeds and torques. They are divided into three sections consisting of Title Heading, Data Input and Results. The Title Heading provides in addition to the title, traceability data of program authors, revision data and run date.

The data input section inputs general vehicle description parameters plus operational assumptions such as:

1. Maximum speed: A value of 45 MPH has been used as a contract requirement.

2. Drag coefficient: A value of 1.0 has been used as a reasonable, yet conservative value throughout this study.

3. Rolling resistance: A value of 100 pounds per ton has been used to represent operation on a smooth, hard surface.

4. Engine gross horsepower: Values of 500 and 1000 have been used for the 19.5 and 40 ton vehicles respectively as directed by the contract.

5. Engine loss horsepower: Values of 60 and 120 have been used for the 19.5 and 40 ton vehicles respectively. See Section A.II.1 for a sample loss budget.

The results section of these tables provide the following data:

1. Grade (%): Increments have been selected to provide the range of data specified in the contract.

2. Speed (MPH): This is the maximum speed the vehicle can maintain on the specified grade.

3. Resistance (Pounds): This is the resistance encountered when operating at the stated speed on the stated grade and equals the tractive effort at this limiting condition.

4. Sprocket Torque and RPM: These data can be used to calculate torques and speeds required in related drive-train components.

```
*****************************************************************************

                    LIMITING GRADE PERFORMANCE
              (FOR ELECTRICAL DRIVE TRACKED VEHICLES)

         BY:  W.E. RODLER          REV.DATE:  11 JUNE 1984
              L.M. FERNANDEZ

                      RUN DATE: 7-AUG-85:11

*****************************************************************************

      DATA INPUT:
      -----------

    MAX. VEL., mph =  45.0                  ENG. GROSS HP. = 500.0
    FRONTAL AREA, sq. ft. =  57.0           ENG. LOSS HP. =  60.0
    GROSS VEHICLE WT., lbs = 39000.0        TRACK PITCH, in = 6.03
    DRAG COEFFICIENT = 1.00                 NO. OF SPROCKET TEETH = 11
    ROLLING RESISTANCE,lb per ton = 100.0

*****************************************************************************

  Efficiency data for Westinghouse induction motor * CONCEPT I:  TWIN
        by Craig Joseph 10-MAY-85                  * PROPULSION MOTORS
*****************************************************************************
      RESULTS:
      --------
```

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	5.37	22019.54	85.45	9681.58
50.00	6.16	19396.87	98.14	8529.35
40.00	7.40	16442.23	117.89	7229.22
30.00	9.52	13169.79	151.64	5792.50
20.00	13.31	9624.37	211.97	4231.75
15.00	16.68	7775.86	265.63	3418.64
10.00	22.06	5901.62	351.28	2596.11
5.00	32.13	4048.05	511.50	1780.58
4.00	35.23	3689.68	560.86	1623.21
3.00	38.77	3338.64	617.29	1468.80
2.00	42.92	2998.36	683.26	1319.10
1.56	45.00	2853.53	716.42	1254.27

```
*****************************************************************************
  End
```

LIMITING GRADE PERFORMANCE
(FOR ELECTRICAL DRIVE TRACKED VEHICLES)

BY: W.E. RODLER   REV.DATE: 11 JUNE 1984
L.M. FERNANDEZ

RUN DATE: 7-AUG-85:12

DATA INPUT:

MAX. VEL., mph = 45.0
FRONTAL AREA, sq. ft. = 57.0
GROSS VEHICLE WT., lbs = 39000.0
DRAG COEFFICIENT = 1.00
ROLLING RESISTANCE,lb per ton = 100.0

ENG. GROSS HP. = 500.0
ENG. LOSS HP. = 60.0
TRACK PITCH, in = 6.03
NO. OF SPROCKET TEETH = 11

Efficiency data for Westinghouse induction motor * CONCEPT II: PROPULSION/
by Craig Joseph 10-MAY-85 * STEER MOTORS

RESULTS:

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	5.25	22019.36	83.60	9669.09
50.00	6.02	19396.62	95.86	8528.54
40.00	7.23	16441.86	115.10	7228.49
30.00	9.29	13169.16	147.95	5791.69
20.00	13.02	9623.24	207.27	4231.07
15.00	16.30	7774.02	259.54	3419.66
10.00	21.61	5898.71	344.00	2594.78
5.00	31.49	4042.16	501.40	1777.94
4.00	34.55	3682.75	550.02	1620.11
3.00	38.07	3330.80	606.16	1465.43
2.00	42.18	2989.18	671.48	1315.08
1.40	45.00	2791.15	716.42	1227.59

End

```
********************************************************************************
                        LIMITING GRADE PERFORMANCE
                  (FOR ELECTRICAL DRIVE TRACKED VEHICLES)

             BY:  W.E. RODLER        REV.DATE:  11 JUNE 1984
                  L.M. FERNANDEZ

                          RUN DATE: 7-AUG-85:10

********************************************************************************
         DATA INPUT:
         -----------

      MAX. VEL., mph =  45.0                   ENG. GROSS HP. = 500.0
      FRONTAL AREA, sq. ft. =  57.0            ENG. LOSS HP. =  60.0
      GROSS VEHICLE WT., lbs = 39000.0         TRACK PITCH, in = 6.03
      DRAG COEFFICIENT = 1.00                  NO. OF SPROCKET TEETH = 11
      ROLLING RESISTANCE,lb per ton = 100.0

********************************************************************************

          Efficiency data for Homopolar motor      * CONCEPT I: TWIN
             given by Gene Seider 20-MAY-85        *PROPULSION MOTORS
********************************************************************************
         RESULTS:
         --------
```

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	5.07	22019.08	80.70	9669.14
50.00	5.82	19396.27	92.69	8529.64
40.00	7.01	16441.40	111.61	7229.25
30.00	9.05	13168.51	144.08	5790.40
20.00	12.65	9621.84	201.32	4231.09
15.00	15.81	7771.71	251.68	3417.52
10.00	20.91	5894.39	332.90	2592.41
5.00	30.25	4030.99	481.64	1773.07
4.00	33.01	3667.61	525.54	1613.12
3.00	36.16	3310.09	575.68	1456.34
2.00	39.79	2960.62	633.43	1302.65
1.00	43.90	2620.96	698.95	1153.27
0.76	45.00	2541.60	716.42	1118.05

```
********************************************************************************
    End
```

```
*****************************************************************************

                   LIMITING GRADE PERFORMANCE
             (FOR ELECTRICAL DRIVE TRACKED VEHICLES)


        BY:  W.E. RODLER          REV.DATE:  11 JUNE 1984
             L.M. FERNANDEZ

                     RUN DATE: 12-AUG-85:106

*****************************************************************************

        DATA INPUT:
        -----------

     MAX. VEL., mph =  45.0                 ENG. GROSS HP. =1000.0
     FRONTAL AREA, sq. ft. =  68.3          ENG. LOSS HP. = 120.0
     GROSS VEHICLE WT., lbs = 80000.0       TRACK PITCH, in = 7.63
     DRAG COEFFICIENT = 1.00                NO. OF SPROCKET TEETH = 11
     ROLLING RESISTANCE,lb per ton = 100.0

*****************************************************************************


   Efficiency data for Westinghouse induction motor * CONCEPT I:  TWIN
         by Craig Joseph 10-MAY-85                  * PROPULSION MOTORS
*****************************************************************************
        RESULTS:
        --------
```

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	5.22	45164.42	65.74	25114.27
50.00	6.00	39783.36	75.50	22119.23
40.00	7.20	33720.31	90.66	18745.93
30.00	9.26	27002.79	116.54	15016.77
20.00	12.98	19718.71	163.44	10963.23
15.00	16.28	15913.51	204.99	8846.72
10.00	21.64	12042.02	272.41	6695.79
5.00	31.83	8171.84	400.73	4545.70
4.00	35.08	7412.21	441.62	4123.02
3.00	38.86	6662.50	489.24	3706.03
2.00	43.39	5928.26	546.25	3297.71
1.69	45.00	5705.27	566.56	3172.08

```
*****************************************************************************
   End
```

```
******************************************************************************
                    LIMITING GRADE PERFORMANCE
               (FOR ELECTRICAL DRIVE TRACKED VEHICLES)

         BY:  W.E. RODLER          REV.DATE:  11 JUNE 1984
              L.M. FERNANDEZ

                     RUN DATE: 12-AUG-85:107
******************************************************************************
     DATA INPUT:
     -----------

    MAX. VEL., mph =  45.0
    FRONTAL AREA, sq. ft. =  68.3           ENG. GROSS HP. =1000.0
    GROSS VEHICLE WT., lbs = 80000.0        ENG. LOSS HP. = 120.0
    DRAG COEFFICIENT = 1.00                 TRACK PITCH, in = 7.63
    ROLLING RESISTANCE,lb per ton = 100.0   NO. OF SPROCKET TEETH = 11
******************************************************************************

  Efficiency data for Westinghouse induction motor * CONCEPT II:  PROPULSION/
       by Craig Joseph 10-MAY-85                    *  STEER MOTORS
******************************************************************************
     RESULTS:
     --------
```

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	5.11	45164.21	64.29	25091.81
50.00	5.86	39783.07	73.75	22117.27
40.00	7.03	33719.88	88.52	18744.21
30.00	9.03	27002.07	113.72	15014.99
20.00	12.69	19717.42	159.81	10962.05
15.00	15.91	15911.41	200.28	8850.32
10.00	21.18	12038.63	266.72	6693.72
5.00	31.18	8164.74	392.60	4541.53
4.00	34.37	7403.70	432.78	4118.07
3.00	38.13	6652.67	480.03	3700.66
2.00	42.60	5916.42	536.32	3291.05
1.54	45.00	5585.32	566.56	3104.59

```
******************************************************************************
End
```

LIMITING GRADE PERFORMANCE
(FOR ELECTRICAL DRIVE TRACKED VEHICLES)

BY: W.E. RODLER   REV.DATE: 11 JUNE 1984
    L.M. FERNANDEZ

RUN DATE: 12-AUG-85:105

DATA INPUT:

MAX. VEL., mph = 45.0
FRONTAL AREA, sq. ft. = 68.3
GROSS VEHICLE WT., lbs = 80000.0
DRAG COEFFICIENT = 1.00
ROLLING RESISTANCE,lb per ton = 100.0

ENG. GROSS HP. =1000.0
ENG. LOSS HP. = 120.0
TRACK PITCH, in = 7.63
NO. OF SPROCKET TEETH = 11

Efficiency data for Homopolar motor given by Gene Seider 20-MAY-85

* CONCEPT I: TWIN
*PROPULSION MOTORS

RESULTS:

GRADE(%)	SPEED(mph)	RESISTANCE(lb)	SPROCKET(rpm)	SPROCKET(lbft)
60.00	4.94	45163.93	62.22	25080.66
50.00	5.68	39782.71	71.47	22120.61
40.00	6.83	33719.41	86.03	18746.69
30.00	8.82	27001.42	111.06	15017.98
20.00	12.37	19715.98	155.69	10963.23
15.00	15.50	15909.19	195.18	8846.90
10.00	20.62	12034.51	259.60	6690.93
5.00	30.25	8154.74	380.85	4535.66
4.00	33.20	7389.82	417.98	4110.52
3.00	36.65	6633.36	461.41	3689.80
2.00	40.72	5889.14	512.70	3275.36
1.11	45.00	5241.41	566.56	2912.90

End

B.2.B Acceleration Tables

The following tables provide acceleration data consisting of time, tractive effort, speed, distance and sprocket RPM, torque and horsepower. These tables are divided into three sections consisting of the Title Heading, Data Input and Results. The Title Heading provides in addition to the subject, traceability data of program author, operator, purpose, revision date and run date.

The Data Input section inputs general vehicle description parameters plus operational assumptions such as:

1. Coefficient of drag: a value of 1.0 has been used as a reasonable, yet conservative value throughout this study. This coefficient is multiplied by the frontal area and the velocity head to provide air resistance.

2. Rolling resistance: a value of 100 pounds per ton has been used to represent operation on a smooth, hard surface. This value is multiplied by the gross vehicle weight in tons to obtain vehicle rolling resistance.

3. Coefficient of friction: a value of 0.7 has been used to represent the contact between the track and the roadway. This is used to limit the maximum possible acceleration to the value that the selected adhesive condition will allow.

4. Mass increment for rotation: This value has been calculated from the motor and gear train data. It is input as a fraction of the translational mass of the vehicle. In the calculations, the translational mass of the vehicle is increased by this amount to correct for the rotational inertia of the system.

5. Grade, %: This value is determined by the operating situation. Most calculations have used level (0%), but it was also used to confirm starting performance on a 60% grade.

The results section provides the following acceleration data:

1. Time (seconds): This is cumulative time from the start of the run. As directed by the contract, no allowance is made for throttle response time.

2. Net tractive effort (pounds): This shows the tractive effort available at the corresponding time. It can be either power or adhesion limited.

3. Speed (MPH): This is the instantaneous speed at the given time.

4. Distance (feet): This is the cumulative distance from the start of the run.

5. Sprocket RPM, LB-FT, and HP: These data can be used to calculate speeds, torques and powers required in the related drive train components.

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                                    VEHICLE ACCELERATION CHARACTERISTICS

       BY:  W.E. RODLER                 OPERATOR:R LEWIS                          REV.DATE: 31 MAY 1985
            R.E.LEWIS                    PURPOSE:ELECTRIC DRIVE PROPOSAL           RUN DATE:7-AUG-85:14

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       DATA INPUT:
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    GROSS VEHICLE WEIGHT, lbs =  39000.          COEFFICIENT OF DRAG = 1.00
    MAXIMUM VELOCITY, mph =  45.0         ROLLING RESISTANCE, lb/ton = 100.0     MASS INCR. FOR ROT, % =47.20
    ENGINE GROSS HP. = 440.0              TRACK PITCH, in. = 6.03                GRADE, % =    0.0
    NUMBER OF SPROCKET TEETH = 11          COEFFICIENT OF FRICTION = 0.70
    FRONTAL AREA, in. =  57.0

    Efficiency data for Westinghouse induction motor *CONCEPT I: TWIN DRIVE MOTORS
         by Craig Joseph 10-MAY-85                   *
************************************************************************************************************

       RESULTS:
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TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	25350.00	0.00	0.00	0.01	12008.04	0.02
0.20	25349.86	0.97	0.14	15.45	12008.04	35.31
0.30	25349.45	1.94	0.43	30.88	12008.04	70.60
0.40	25348.77	2.91	0.85	46.31	12008.04	105.89
0.50	25347.81	3.88	1.42	61.75	12008.04	141.18
0.60	22818.72	4.85	2.13	77.18	10896.15	160.12
0.70	19467.64	5.72	2.97	91.07	9422.76	163.40
0.80	17206.92	6.46	3.92	102.93	8428.95	165.18
0.90	15602.17	7.12	4.97	113.40	7723.67	166.77
1.00	14383.55	7.72	6.10	122.90	7188.22	168.21
2.00	8926.67	12.07	21.19	192.23	4793.51	175.45
3.00	6837.88	15.08	41.42	240.11	3879.98	177.39
4.00	5682.46	17.48	65.53	278.30	3376.77	178.93

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	4885.13	19.51	92.85	310.60	3030.87	179.24
6.00	4302.27	21.27	122.91	338.66	2779.11	179.20
7.00	3857.91	22.84	155.39	363.58	2588.08	179.16
8.00	3504.53	24.25	190.04	386.06	2436.91	179.13
9.00	3214.72	25.54	226.66	406.58	2313.55	179.10
10.00	2971.43	26.72	265.08	425.46	2210.51	179.07
11.00	2763.38	27.82	305.18	442.97	2122.85	179.05
12.00	2582.82	28.85	346.82	459.29	2047.15	179.02
13.00	2424.18	29.81	389.91	474.57	1980.98	179.00
14.00	2283.37	30.71	434.37	488.93	1922.55	178.98
15.00	2157.31	31.56	480.10	502.48	1870.50	178.96
16.00	2^43.59	32.37	527.05	515.30	1823.78	178.94
17.00	1940.35	33.13	575.14	527.46	1781.57	178.92
18.00	1846.08	33.86	624.32	539.01	1743.23	178.91
19.00	1759.58	34.55	674.54	550.01	1708.21	178.89
20.00	1679.86	35.21	725.75	560.50	1676.09	178.87
21.00	1606.09	35.84	777.89	570.52	1646.51	178.86
22.00	1535.51	36.44	830.94	580.11	1618.26	178.74

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	1469.14	37.01	884.85	589.27	1591.77	178.60
24.00	1407.25	37.56	939.59	598.04	1567.18	178.45
25.00	1349.37	38.09	995.11	606.45	1544.29	178.32
26.00	1295.11	38.60	1051.39	614.52	1522.91	178.19
27.00	1244.12	39.09	1108.40	622.26	1502.91	178.07
28.00	1196.12	39.55	1166.10	629.70	1484.15	177.95
29.00	1150.83	40.00	1224.48	636.86	1466.52	177.83
30.00	1108.03	40.44	1283.50	643.75	1449.93	177.72
31.00	1067.51	40.85	1343.14	650.38	1434.28	177.61
32.00	1029.09	41.25	1403.38	656.77	1419.50	177.51
33.00	992.62	41.64	1464.20	662.94	1405.51	177.41
34.00	957.95	42.01	1525.58	668.89	1392.26	177.32
35.00	924.94	42.38	1587.49	674.63	1379.70	177.22
36.00	893.49	42.72	1649.93	680.17	1367.77	177.14
37.00	863.49	43.06	1712.86	685.53	1356.42	177.05
38.00	834.83	43.39	1776.28	690.71	1345.62	176.97
39.00	807.44	43.70	1840.16	695.71	1335.33	176.89
40.00	781.24	44.00	1904.50	700.56	1325.51	176.81

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	756.15	44.30	1969.28	705.25	1316.14	176.73
42.00	732.10	44.58	2034.48	709.78	1307.19	176.66
43.00	709.04	44.86	2100.09	714.18	1298.63	176.59
43.50	697.36	45.00	2146.25	716.42	1294.30	176.55

End

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                                 VEHICLE ACCELERATION CHARACTERISTICS

      BY:  W.E. RODLER                 OPERATOR:R LEWIS                      REV.DATE: 31 MAY 1985
           R.E.LEWIS                    PURPOSE:ELECTRIC DRIVE PROPOSAL       RUN DATE:7-JUL-85:15

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      DATA INPUT:
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   GROSS VEHICLE WEIGHT, lbs =  39000.        COEFFICIENT OF DRAG = 1.00
   MAXIMUM VELOCITY, mph =  45.0          ROLLING RESISTANCE, lb/ton = 100.0     MASS INCR. FOR ROT, % =47.20
   ENGINE GROSS HP. = 440.0               TRACK PITCH, in. = 6.03                GRADE, % =    0.0
   NUMBER OF SPROCKET TEETH = 11           COEFFICIENT OF FRICTION = 0.70
   FRONTAL AREA, in. =  57.0

   Efficiency data for Westinghouse induction motor *CONCEPT II: PROPULSION/STEER MOTOR
        by Craig Joseph 10-MAY-85                     *
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      RESULTS:
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TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	25350.00	0.00	0.00	0.01	12008.04	0.02
0.20	25349.86	0.97	0.14	15.45	12008.04	35.31
0.30	25349.45	1.94	0.43	30.88	12008.04	70.60
0.40	25348.77	2.91	0.85	46.31	12008.04	105.89
0.50	25347.81	3.88	1.42	61.75	12008.04	141.18
0.60	22[illegible]52.57	4.85	2.13	77.18	10559.16	155.17
0.70	18903.04	5.69	2.97	90.61	9174.39	158.27
0.80	16747.82	6.41	3.91	102.11	8226.97	159.96
0.90	15207.34	7.05	4.94	112.31	7549.93	161.45
1.00	14032.38	7.64	6.06	121.57	7033.67	162.81
2.00	8744.13	11.89	20.95	189.34	4712.94	169.91
3.00	6698.23	14.84	40.86	236.25	3818.09	171.75
4.00	5564.87	17.19	64.57	273.65	3324.40	173.22

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	4789.87	19.18	91.43	305.31	2988.15	173.71
6.00	4216.87	20.91	120.97	332.82	2740.55	173.67
7.00	3780.05	22.44	152.89	357.24	2552.68	173.63
8.00	3432.69	23.82	186.93	379.27	2403.99	173.60
9.00	3147.85	25.08	222.91	399.36	2282.66	173.57
10.00	2908.75	26.25	260.64	417.85	2181.32	173.55
11.00	2704.33	27.32	300.02	434.98	2095.10	173.52
12.00	2526.94	28.33	340.91	450.95	2020.65	173.50
13.00	2371.11	29.26	383.22	465.90	1955.58	173.48
14.00	2232.82	30.15	426.85	479.95	1898.11	173.46
15.00	2109.03	30.98	471.75	493.20	1846.92	173.44
16.00	1997.38	31.77	517.82	505.73	1800.98	173.42
17.00	1896.03	32.51	565.02	517.61	1759.47	173.40
18.00	1803.51	33.22	613.28	528.89	1721.77	173.39
19.00	1718.63	33.90	662.55	539.64	1687.34	173.37
20.00	1640.41	34.54	712.79	549.88	1655.75	173.36
21.00	1568.04	35.15	763.95	559.67	1626.67	173.34
22.00	1500.85	35.74	815.98	569.03	1599.79	173.33

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	1436.85	36.31	868.86	577.99	1574.24	173.25
24.00	1376.04	36.84	922.55	586.57	1550.02	173.11
25.00	1319.18	37.36	977.00	594.79	1527.47	172.99
26.00	1265.89	37.86	1032.20	602.68	1506.41	172.86
27.00	1215.82	38.33	1088.11	610.24	1486.72	172.75
28.00	1168.70	38.79	1144.70	617.52	1468.24	172.63
29.00	1124.24	39.23	1201.94	624.51	1450.89	172.52
30.00	1082.24	39.65	1259.82	631.24	1434.55	172.42
31.00	1042.49	40.06	1318.30	637.72	1419.15	172.32
32.00	1004.81	40.45	1377.37	643.96	1404.60	172.22
33.00	969.04	40.83	1437.00	649.98	1390.83	172.13
34.00	935.04	41.19	1497.17	655.78	1377.80	172.04
35.00	902.68	41.54	1557.87	661.39	1365.43	171.95
36.00	871.85	41.88	1619.08	666.80	1353.69	171.87
37.00	842.44	42.21	1680.77	672.02	1342.52	171.78
38.00	814.36	42.53	1742.94	677.08	1331.90	171.71
39.00	787.53	42.84	1805.57	681.96	1321.77	171.63
40.00	761.86	43.13	1868.63	686.68	1312.12	171.56

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	737.29	43.42	1932.13	691.25	1302.90	171.48
42.00	713.74	43.70	1996.03	695.68	1294.10	171.42
43.00	691.16	43.97	2060.34	699.96	1285.68	171.35
44.00	669.50	44.23	2125.04	704.11	1277.62	171.28
45.00	648.70	44.48	2190.11	708.13	1269.91	171.22
46.00	628.71	44.72	2255.54	712.02	1262.52	171.16
47.00	609.49	44.96	2321.33	715.80	1255.43	171.10
47.10	606.35	45.00	2341.13	716.42	1254.27	171.09

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End

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VEHICLE ACCELERATION CHARACTERISTICS

BY: W.E. RODLER
R.E.LEWIS

OPERATOR:R LEWIS
PURPOSE:ELECTRIC DRIVE PROPOSAL

REV.DATE: 31 MAY 1985
RUN DATE:7-AUG-85;13

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DATA INPUT:

GROSS VEHICLE WEIGHT, lbs = 39000.
MAXIMUM VELOCITY, mph = 45.0
ENGINE GROSS HP. = 440.0
NUMBER OF SPROCKET TEETH = 11
FRONTAL AREA, in. = 57.0

COEFFICIENT OF DRAG = 1.00
ROLLING RESISTANCE, lb/ton = 100.0
TRACK PITCH, in. = 6.03
COEFFICIENT OF FRICTION = 0.70

MASS INCR. FOR ROT, % =28.40
GRADE, % = 0.0

Efficiency data for Homopolar motor
given by Gene Seider 20-MAY-85

*CONCEPT I: TWIN DRIVE MOTORS
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RESULTS:

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	25350.00	0.00	0.00	0.01	12008.04	0.02
0.20	25349.82	1.11	0.16	17.70	12008.04	40.48
0.30	25349.28	2.22	0.49	35.40	12008.04	80.93
0.40	25348.38	3.33	0.98	53.09	12008.04	121.39
0.50	23607.38	4.45	1.63	70.79	11242.81	151.53
0.60	19175.76	5.48	2.43	87.26	9294.20	154.42
0.70	16631.74	6.32	3.36	100.65	8175.83	156.68
0.80	14916.52	7.05	4.40	112.26	7422.01	158.64
0.90	13654.31	7.71	5.53	122.67	6867.44	160.40
1.00	12671.76	8.30	6.74	132.20	6435.88	162.00
2.00	7907.54	12.71	22.73	202.31	4346.24	167.42
3.00	6052.60	15.77	43.94	250.99	3535.92	168.98
4.00	5000.64	18.19	69.08	289.66	3078.50	169.78

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	4277.75	20.23	97.45	322.14	2765.56	169.63
6.00	3756.23	22.00	128.58	350.27	2540.95	169.46
7.00	3355.93	23.57	162.13	375.18	2369.45	169.26
8.00	3036.46	24.97	197.85	397.56	2233.31	169.05
9.00	2772.28	26.25	235.52	417.90	2121.30	168.79
10.00	2550.06	27.42	274.97	436.53	2027.58	168.53
11.00	2359.36	28.50	316.07	453.71	1947.57	168.25
12.00	2194.10	29.50	358.68	469.65	1878.60	167.99
13.00	)48.68	30.43	402.71	484.50	1818.23	167.73
14.00	1918.70	31.30	448.05	498.38	1764.51	167.44
15.00	1799.76	32.12	494.63	511.39	1715.51	167.04
16.00	1692.13	32.89	542.37	523.61	1671.37	166.63
17.00	1594.87	33.61	591.19	535.11	1631.67	166.25
18.00	1506.46	34.29	641.05	545.96	1595.75	165.88
19.00	1425.31	34.94	691.87	556.22	1562.92	165.52
20.00	1349.89	35.55	743.60	565.93	1532.50	165.13
21.00	1280.22	36.13	796.21	575.13	1504.51	164.75
22.00	1215.02	36.67	849.64	583.85	1478.39	164.35

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	1154.66	37.19	903.85	592.14	1454.31	163.97
24.00	1098.61	37.69	958.80	600.02	1432.03	163.60
25.00	1046.41	38.16	1014.46	607.53	1411.36	163.26
26.00	1002.02	38.61	1070.80	614.69	1394.05	163.16
27.00	954.99	39.04	1127.77	621.53	1375.50	162.78
28.00	910.96	39.45	1185.37	628.06	1358.20	162.42
29.00	869.67	39.84	1243.54	634.29	1342.03	162.08
30.00	830.87	40.21	1302.28	640.23	1326.88	161.75
31.00	794.29	40.57	1361.55	645.92	1312.64	161.43
32.00	759.56	40.91	1421.33	651.35	1299.15	161.12
33.00	726.80	41.24	1481.61	656.55	1286.46	160.82
34.00	695.84	41.55	1542.34	661.52	1274.50	160.53
35.00	566.56	41.85	1603.53	666.29	1263.22	160.26
36.00	638.82	42.14	1665.14	670.85	1252.56	159.99
37.00	612.52	42.41	1727.17	675.23	1242.48	159.74
38.00	587.56	42.68	1789.59	679.42	1232.94	159.50
39.00	563.85	42.93	1852.39	683.45	1223.90	159.27
40.00	541.30	43.17	1915.55	687.31	1215.32	159.05

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	›19.84	43.40	1979.05	691.02	1207.18	158.83
42.00	499.41	43.63	2042.90	694.59	1199.44	158.63
43.00	479.93	43.84	2107.06	698.01	1192.08	158.43
44.00	461.36	44.05	2171.53	701.30	1185.07	158.24
45.00	443.63	44.25	2236.30	704.47	1178.40	158.06
46.00	426.70	44.44	2301.35	707.51	1172.04	157.89
47.00	410.52	44.62	2366.68	710.44	1165.98	157.72
48.00	395.06	44.80	2432.27	713.25	1160.19	157.56
49.00	380.26	44.97	2498.12	715.96	1154.66	157.41
49.10	377.79	45.00	2517.92	716.42	1153.74	157.38

End

VEHICLE ACCELERATION CHARACTERISTICS

BY: W.E. RODLER
R.E.LEWIS

OPERATOR:R LEWIS
PURPOSE:ELECTRIC DRIVE PROPOSAL

REV.DATE: 31 MAY 1985
RUN DATE:12-AUG-85:101

DATA INPUT:

GROSS VEHICLE WEIGHT, lbs = 80000.
MAXIMUM VELOCITY, mph = 45.0
ENGINE NET HP. = 880.0
NUMBER OF SPROCKET TEETH = 11
FRONTAL AREA, in. = 68.3

COEFFICIENT OF DRAG = 1.00
ROLLING RESISTANCE, lb/ton = 100.0
TRACK PITCH, in. = 7.63
COEFFICIENT OF FRICTION = 0.70

MASS INCR. FOR ROT, % =47.20
GRADE, % = 0.0

Efficiency data for Westinghouse induction motor *CONCEPT I: TWIN DRIVE MOTORS
by Craig Joseph 10-MAY-85 *

RESULTS:

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	52000.00	0.00	0.00	0.01	31147.28	0.05
0.20	51999.84	0.97	0.14	12.21	31147.29	72.44
0.30	51999.34	1.94	0.43	24.42	31147.28	144.82
0.40	51998.52	2.91	0.85	36.63	31147.28	217.21
0.50	51997.38	3.88	1.42	48.83	31147.28	289.59
0.60	45539.65	4.85	2.13	61.04	27556.31	320.24
0.70	39001.55	5.70	2.97	71.73	23920.67	326.68
0.80	34540.13	6.42	3.91	80.88	21440.08	330.17
0.90	31355.77	7.07	4.95	88.99	19669.78	333.27
1.00	28929.23	7.65	6.07	96.35	18320.97	336.09
2.00	18022.87	11.93	20.99	150.20	12262.97	350.71
3.00	13816.69	14.89	40.98	187.49	9931.20	354.53
4.00	11490.17	17.26	64.78	217.25	8644.56	357.58

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	9897.58	19.26	91.74	242.45	7765.85	358.50
6.00	8724.48	21.00	121.41	264.38	7120.18	358.42
7.00	7831.26	22.55	153.48	283.87	6629.92	358.34
8.00	7121.83	23.94	187.69	301.47	6241.64	358.28
9.00	6540.77	25.22	223.86	317.55	5924.55	358.22
10.00	6053.56	26.40	261.81	332.38	5659.47	358.16
11.00	5637.45	27.49	301.42	346.13	5433.74	358.11
12.00	5276.73	28.51	342.57	358.97	5238.66	358.06
13.00	4960.16	29.47	385.17	371.02	5067.96	358.02
14.00	4679.47	30.37	429.12	382.36	4917.08	357.98
15.00	4428.41	31.22	474.36	393.07	4782.52	357.94
16.00	4202.15	32.03	520.80	403.22	4661.63	357.90
17.00	3996.91	32.79	568.40	412.87	4552.29	357.86
18.00	3809.66	33.52	617.09	422.05	4452.84	357.83
19.00	3637.96	34.22	666.82	430.80	4361.92	357.79
20.00	3479.82	34.88	717.54	439.17	4278.42	357.76
21.00	3333.56	35.52	769.22	447.19	4201.42	357.73
22.00	3196.57	36.13	821.81	454.86	4129.46	357.64

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	3064.76	36.71	875.27	462.23	4060.29	357.35
24.00	2941.88	37.27	929.57	469.29	3995.97	357.06
25.00	2827.00	37.81	984.68	476.07	3936.00	356.78
26.00	2719.31	38.33	1040.56	482.59	3879.94	356.52
27.00	2618.14	38.83	1097.18	488.87	3827.40	356.26
28.00	2522.87	39.31	1154.52	494.91	3778.05	356.02
29.00	2432.99	39.77	1212.55	500.74	3731.61	355.78
30.00	2348.04	40.22	1271.24	506.36	3687.83	355.55
31.00	2267.60	40.65	1330.58	511.78	3646.47	355.33
32.00	2191.31	41.07	1390.54	517.02	3607.34	355.12
33.00	2118.86	41.47	1451.09	522.09	3570.27	354.91
34.00	2049.95	41.86	1512.23	526.99	3535.09	354.71
35.00	1984.32	42.23	1573.92	531.73	3501.66	354.52
36.00	1921.75	42.60	1636.16	536.32	3469.86	354.33
37.00	1862.02	42.95	1698.93	540.77	3439.57	354.15
38.00	1804.94	43.29	1762.20	545.08	3410.69	353.98
39.00	1750.34	43.63	1825.97	549.26	3383.12	353.81
40.00	1698.06	43.95	1890.21	553.31	3356.78	353.65

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	1647.96	44.26	1954.92	557.24	3331.59	353.49
42.00	1599.90	44.56	2020.08	561.06	3307.47	353.33
43.00	1553.77	44.86	2085.68	564.77	3284.37	353.18
43.40	1531.66	45.00	2125.24	566.56	3273.32	353.11

End

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                              VEHICLE ACCELERATION CHARACTERISTICS

   BY:  W.E. RODLER               OPERATOR:R LEWIS                       REV.DATE: 31 MAY 1985
        R.E.LEWIS                  PURPOSE:ELECTRIC DRIVE PROPOSAL         RUN DATE:12-AUG-85:102

****************************************************************************************************
   DATA INPUT:
   -----------

GROSS VEHICLE WEIGHT, lbs =  80000.          COEFFICIENT OF DRAG = 1.00
MAXIMUM VELOCITY, mph =  45.0        ROLLING RESISTANCE, lb/ton = 100.0    MASS INCR. FOR ROT, % =47.20
ENGINE NET HP. = 880.0               TRACK PITCH, in. = 7.63               GRADE, % =    0.0
NUMBER OF SPROCKET TEETH = 11         COEFFICIENT OF FRICTION = 0.70
FRONTAL AREA, in. =  68.3

Efficiency data for Westinghouse induction motor *CONCEPT II: PROPULSION/STEER MOTOR
      by Craig Joseph 10-MAY-85                  *
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RESULTS:

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	52000.00	0.00	0.00	0.01	31147.28	0.05
0.20	51999.84	0.97	0.14	12.21	31147.28	72.44
0.30	51999.34	1.94	0.43	24.42	31147.28	144.82
0.40	51998.52	2.91	0.85	36.63	31147.28	217.21
0.50	51997.38	3.88	1.42	48.83	31147.28	289.59
0.60	44007.37	4.85	2.13	61.04	26704.05	310.34
0.70	37863.94	5.67	2.96	71.37	23287.90	316.44
0.80	33612.46	6.37	3.90	80.25	20924.05	319.73
0.90	30556.95	7.00	4.93	88.14	19225.38	322.65
1.00	28218.30	7.57	6.04	95.32	17925.43	325.32
2.00	17652.18	11.75	20.75	147.96	12056.38	339.64
3.00	13532.98	14.65	40.42	184.47	9772.71	343.26
4.00	11251.00	16.97	63.83	213.62	8510.58	346.16

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	9703.37	18.93	90.34	238.31	7656.62	347.43
6.00	8550.02	20.64	119.50	259.81	7021.68	347.35
7.00	7671.83	22.15	151.01	278.90	6539.54	347.28
8.00	6974.38	23.52	184.62	296.15	6157.68	347.22
9.00	6403.17	24.77	220.14	311.89	5845.84	347.16
10.00	5924.27	25.93	257.42	326.40	5585.15	347.11
11.00	5515.30	26.99	296.31	339.86	5363.17	347.06
12.00	5160.80	27.99	336.72	352.43	5171.32	347.01
13.00	4849.74	28.93	378.53	364.20	5003.48	346.97
14.00	4573.96	29.81	421.68	375.29	4855.11	346.93
15.00	4327.33	30.64	466.07	385.76	4722.82	346.89
16.00	4105.09	31.43	511.65	395.68	4603.95	346.86
17.00	3903.53	32.18	558.35	405.10	4496.47	346.82
18.00	3719.66	32.89	606.12	414.06	4398.70	346.79
19.00	3551.09	33.57	654.91	422.61	4309.32	346.76
20.00	3395.85	34.22	704.67	430.78	4227.24	346.73
21.00	3252.30	34.84	755.36	438.60	4151.56	346.70
22.00	3119.08	35.43	806.93	446.09	4081.52	346.67

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	2995.01	36.00	859.36	453.28	4016.48	346.65
24.00	2874.20	36.55	912.61	460.18	3953.14	346.37
25.00	2761.28	37.08	966.65	466.81	3894.10	346.11
26.00	2655.45	37.58	1021.44	473.17	3838.90	345.86
27.00	2556.04	38.07	1076.95	479.30	3787.19	345.62
28.00	2462.46	38.54	1133.17	485.20	3738.62	345.39
29.00	2374.19	38.99	1190.06	490.89	3692.92	345.16
30.00	2290.77	39.43	1247.59	496.37	3649.84	344.95
31.00	2211.79	39.85	1305.76	501.66	3609.15	344.74
32.00	2136.91	40.25	1364.53	506.77	3570.66	344.54
33.00	2065.81	40.64	1423.88	511.71	3534.19	344.34
34.00	1998.20	41.02	1483.80	516.49	3499.59	344.16
35.00	1933.82	41.39	1544.27	521.11	3466.72	343.97
36.00	1872.44	41.75	1605.26	525.59	3435.46	343.80
37.00	1813.87	42.09	1666.77	529.92	3405.68	343.63
38.00	1757.91	42.42	1728.77	534.12	3377.29	343.46
39.00	1704.38	42.75	1791.25	538.19	3350.19	343.30
40.00	1653.14	43.06	1854.20	542.13	3324.30	343.15

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	1604.04	43.36	1917.60	545.96	3299.54	343.00
42.00	1556.96	43.66	1981.44	549.68	3275.85	342.85
43.00	1511.77	43.95	2045.71	553.28	3253.15	342.71
44.00	1468.36	44.22	2110.38	556.78	3231.39	342.57
45.00	1426.64	44.49	2175.47	560.19	3210.51	342.44
46.00	1386.50	44.76	2240.94	563.49	3190.46	342.31
46.90	1349.65	45.00	2313.39	566.56	3172.08	342.19

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End

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VEHICLE ACCELERATION CHARACTERISTICS

BY: W.E. RODLER OPERATOR:R LEWIS REV.DATE: 31 MAY 1985
R.E.LEWIS PURPOSE:ELECTRIC DRIVE PROPOSAL RUN DATE:12-AUG-85:100

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DATA INPUT:

GROSS VEHICLE WEIGHT, lbs = 80000.
MAXIMUM VELOCITY, mph = 45.0
ENGINE NET HP. = 890.0
NUMBER OF SPROCKET TEETH = 11
FRONTAL AREA, in. = 68.3

COEFFICIENT OF DRAG = 1.00
ROLLING RESISTANCE, lb/ton = 100.0
TRACK PITCH, in. = 7.63
COEFFICIENT OF FRICTION = 0.70

MASS INCR. FOR ROT, % =24.60
GRADE, % = 0.0

Efficiency data for Homopolar motor *CONCEPT I: TWIN DRIVE MOTORS
given by Gene Seider 20-MAY-85 *

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RESULTS:

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
0.10	39335.36	0.00	0.00	0.01	24103.19	0.04
0.20	51999.87	0.87	0.13	10.92	31147.28	64.74
0.30	51999.29	2.01	0.42	25.34	31147.28	150.25
0.40	51998.26	3.16	0.89	39.76	31147.28	235.77
0.50	48629.70	4.30	1.52	54.17	29274.51	301.97
0.60	39115.36	5.37	2.30	67.66	23983.62	308.97
0.70	33717.80	6.24	3.22	78.51	20982.47	313.64
0.80	30135.19	6.98	4.24	87.86	18990.77	317.68
0.90	27522.85	7.64	5.36	96.21	17538.72	321.29
1.00	25503.21	8.25	6.57	103.84	16416.34	324.59
2.00	15833.50	12.69	22.52	159.75	11047.05	336.02
3.00	12109.34	15.76	43.71	198.46	8984.16	339.49
4.00	10005.39	18.20	68.85	229.19	7821.99	341.35

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
5.00	8565.49	20.26	97.25	255.02	7028.78	341.30
6.00	7529.85	22.03	128.42	277.41	6460.05	341.22
7.00	6736.09	23.61	162.03	297.26	6025.55	341.04
8.00	6103.65	25.03	197.82	315.12	5680.48	340.83
9.00	5583.48	26.32	235.58	331.37	5397.60	340.56
10.00	5146.07	27.51	275.15	346.29	5160.50	340.26
11.00	4771.14	28.60	316.39	360.08	4957.93	339.92
12.00	4446.47	29.62	359.16	372.90	4783.11	339.61
13.00	4151.17	30.57	403.38	384.86	4629.97	339.28
14.00	3907.59	31.46	448.94	396.08	4494.30	338.94
15.00	3673.79	32.30	495.76	406.62	4369.44	338.29
16.00	3463.53	33.08	543.77	416.54	4257.49	337.66
17.00	3273.49	33.83	592.90	425.90	4156.62	337.07
18.00	3100.72	34.53	643.08	434.76	4065.20	336.52
19.00	2941.89	35.20	694.27	443.16	3981.37	335.94
20.00	2795.65	35.83	746.41	451.13	3904.40	335.37
21.00	2659.13	36.43	799.45	458.71	3832.69	334.75
22.00	2532.35	37.01	853.36	465.92	3766.26	334.12

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RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
23.00	2414.85	37.55	908.08	472.79	3704.86	333.52
24.00	2305.60	38.07	963.58	479.35	3647.92	332.95
25.00	2208.23	38.57	1019.82	485.62	3597.47	332.64
26.00	2111.44	39.05	1076.78	491.62	3547.23	332.04
27.00	2020.83	39.50	1134.42	497.36	3500.31	331.48
28.00	1935.83	39.94	1192.71	502.86	3456.39	330.94
29.00	1855.92	40.36	1251.63	508.13	3415.21	330.42
30.00	1780.18	40.76	1311.15	513.18	3376.24	329.90
31.00	1708.51	41.15	1371.25	518.02	3339.44	329.38
32.00	1640.82	41.51	1431.89	522.68	3304.76	328.89
33.00	1576.79	41.87	1493.07	527.15	3272.02	328.41
34.00	1516.15	42.21	1554.75	531.44	3241.07	327.96
35.00	1458.63	42.54	1616.93	535.57	3211.78	327.52
36.00	1404.02	42.85	1679.58	539.55	3184.02	327.10
37.00	1352.10	43.16	1742.68	543.38	3157.69	326.70
38.00	1302.69	43.45	1806.22	547.06	3132.67	326.31
39.00	1255.62	43.73	1870.17	550.62	3108.88	325.93
40.00	1210.75	44.01	1934.54	554.04	3086.24	325.57

RESULTS (continued):

TIME (sec)	NET T.E. (lbs)	SPEED (mph)	DISTANCE (ft)	SPROCKET (rpm)	SPROCKET (lb-ft each)	SPROCKET (hp each)
41.00	1167.92	44.27	1999.29	557.35	3064.66	325.22
42.00	1[illegible]27.02	44.52	2064.42	560.53	3044.10	324.89
43.00	1087.92	44.77	2129.92	563.61	3024.47	324.57
43.90	1050.80	45.00	2202.37	566.56	3005.86	324.26

End

B.2.C Maximum Turn Conditions

The following tables provide drivetrain dat for a vehicle in a turn. These tables are divided into three sections consisting of Title Heading, Data Input and Results. The Title Heading provides in addition to the title, traceability data of program authors, revision data and run date.

The data input section is generally similar to the previous sections except that an input titled "Maximum Acceleration" has been added. This input is the maximum lateral acceleration that the vehicle is to develop in a turn. For this study, a value of 0.5 has been used as representative of aggressive but not reckless driving.

The Results section provides the following data:

1. Vehicle speed in 1.5 MPH increments to 45 MPH.

2. Lateral acceleration in G's, limited either by available power or by the selected maximum.

3. Turn radius in feet measured to the centerline of the vehicle.

4. Data for inner and outer sprockets is presented in four columns each as follows:

   a. Apparent horsepower is the combined power at the sprocket and is the value that would be determined by use of a torque meter and RPM counter.

   b. Propulsion horsepower is the fraction of the apparent power that is used to propel the vehicle.

   c. Sprocket RPM with a negative sign indicates reverse rotation.

   d. Sprocket torque with a negative sign indicates a retarding rather than driving torque.

5. Scrub horsepower is the power loss due to scrubbing the tracks around a turn and power flow is always from the vehicle to the tracks.

6. Transfer horsepower is the regenerated power that enters the inner sprocket, is transferred by the drive train to the outer sprocket.

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*******************************************************************************************
                                SPROCKET HORSEPOWER
                      BY:  W.E. RODLER         REV.DATE:  14 MAY 1985
                           L.M. FERNANDEZ

                              RUN DATE: 7-AUG-85:2

*******************************************************************************************

       DATA INPUT:
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    GROSS VEHICLE WEIGHT, tons =  19.5   TREAD WIDTH, in. =  92.5             GRADE, % =  0.0
    MAXIMUM VELOCITY, mph =  45.0        TRACK LENGTH, in. = 150.0            COEFFICIENT OF FRICTION = 0.70
    ENGINE GROSS HP. = 500.0             TRACK PITCH, in. = 6.03              MAXIMUM ACCELERATION, gs =0.50
    LOSS ENGINE HP. =  60.0              NUMBER OF SPROCKET TEETH = 11
    FRONTAL AREA, in. =  57.0            ROLLING RESISTANCE,lb per ton= 100.0  COEFICIENT OF DRAG = 1.00

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    Efficiency data for Westinghouse induction motor * CONCEPT I:  TWIN PROPULSION MOTORS
         by Craig Joseph 10-MAY-85                   *
*******************************************************************************************

       RESULTS:
       --------

 VEH  *LATERAL* TURN *        INNER  SPROCKET        *      OUTER  SPROCKET          * SCRUB *TRANSFR*
SPEED * ACCEL *RADIUS*APPARNT*  PROP *  RPM  *TORQUE *APPARNT*  PROP *  RPM  *TORQUE *  HP   *  HP   *
(mph) * (gs)  * (ft) *  HP   *  HP  *        *(ftlbs)*  HP   *  HP  *        *(ftlbs)*       *       *

  0.00*  0.000*  0.00* 175.31*    15.4* -94.1*-9783.3* 175.37*    15.4* 94.14* 9783.3*  160.0*    0.0

  1.50*  0.089*  1.69* 121.28*    10.7* -65.8*-9686.7* 209.37*    18.5*113.52* 9686.7*  150.7*   40.1

  3.00*  0.071*  8.49* -17.47*     2.0*  12.1*-7591.5* 147.87*    13.6* 83.44* 9308.1*   57.4*   76.8

  4.50*  0.151*  8.97* -30.20*     3.4*  21.0*-7564.9* 216.19*    20.0*122.32* 9283.0*   81.3*  114.9

  6.00*  0.256*  9.40* -44.55*     5.1*  31.0*-7540.8* 282.15*    26.2*160.02* 9260.8*  103.2*  152.8

  7.50*  0.360* 10.46* -66.93*     7.7*  47.0*-7482.0* 335.19*    31.5*191.83* 9204.7*  115.1*  189.7

  9.00*  0.434* 12.47* -98.82*    11.6*  70.4*-7372.9* 374.50*    35.5*216.17* 9098.8*  114.3*  224.7

 10.50*  0.500* 14.75*-131.49*    15.7*  95.2*-7251.1* 408.83*    39.4*239.09* 8980.7*  111.1*  258.3

 12.00*  0.500* 19.26*-171.14*    21.1* 128.1*-7016.1* 423.13*    41.9*253.98* 8750.1*   94.5*  286.7

 13.50*  0.500* 24.38*-204.56*    26.3* 159.0*-6757.8* 438.20*    44.8*270.87* 8496.7*   81.2*  312.1

 15.00*  0.500* 30.10*-232.48*    31.3* 188.5*-6479.0* 452.73*    48.0*289.15* 8223.3*   70.5*  334.2

 16.50*  0.500* 36.42*-255.34*    36.1* 216.9*-6182.4* 465.89*    51.4*308.46* 7932.7*   61.5*  353.0

 18.00*  0.500* 43.34*-273.43*    40.9* 244.6*-5870.9* 477.14*    55.0*328.52* 7628.0*   53.9*  368.3

 19.50*  0.500* 50.86*-287.01*    45.6* 271.7*-5547.7* 486.12*    58.6*349.18* 7311.9*   47.4*  380.1
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SPROCKET HORSEPOWER RUN DATE;No. 7-AUG-85;2

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (ftlbs)	INNER SPROCKET APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
21.00	0.500	58.99	-296.29	50.3	298.4	-5215.6	492.65	62.5	370.29	6987.6	41.8	388.4
22.50	0.500	67.72	-301.49	55.0	324.6	-4877.5	496.63	66.4	391.77	6657.8	36.9	393.4
24.00	0.500	77.05	-302.83	59.7	350.6	-4536.2	498.08	70.4	413.56	6325.6	32.5	395.1
25.50	0.500	86.98	-300.57	64.5	376.4	-4194.5	497.07	74.6	435.59	5993.4	28.7	393.7
27.00	0.500	97.51	-294.97	69.2	401.9	-3855.0	493.72	78.8	457.82	5663.9	25.3	389.5
28.50	0.500	108.65	-286.32	74.0	427.2	-3519.9	488.22	83.2	480.23	5339.5	22.3	382.7
30.00	0.500	120.38	-274.92	78.9	452.4	-3191.3	480.78	87.6	502.79	5022.2	19.7	373.5
31.50	0.500	132.72	-261.06	83.8	477.5	-2871.3	471.63	92.2	525.47	4714.0	17.3	362.1
33.00	0.500	145.66	-245.06	88.7	502.5	-2561.4	461.04	96.8	548.26	4416.6	15.2	349.0
34.50	0.500	159.21	-227.25	93.8	527.4	-2263.2	449.26	101.6	571.14	4131.3	13.3	334.4
36.00	0.500	173.35	-207.91	98.9	552.2	-1977.7	436.57	106.4	594.11	3859.3	11.7	318.5
37.50	0.500	188.10	-187.37	104.1	576.9	-1705.9	423.22	111.4	617.15	3601.7	10.2	301.7
39.00	0.500	203.45	-165.89	109.4	601.5	-1448.4	409.47	116.5	640.26	3358.9	8.9	284.2
40.50	0.500	219.40	-143.75	114.8	626.1	-1205.8	395.58	121.6	663.42	3131.6	7.7	266.2
42.00	0.500	235.95	-121.20	120.3	650.7	-978.3	381.75	126.9	686.64	2920.0	6.7	248.2
43.50	0.500	253.11	-98.47	125.9	675.2	-766.0	368.20	132.3	709.90	2724.1	5.8	230.1
45.00	0.500	270.86	-75.75	131.6	699.6	-568.7	355.12	137.9	733.20	2543.8	5.0	212.3

End

SPROCKET HORSEPOWER

BY: W.E. RODLER REV.DATE: 13 JUNE 1985
R.E. LEWIS

RUN DATE: 7-AUG-85;3

DATA INPUT:

GROSS VEHICLE WEIGHT, tons = 19.5	TREAD WIDTH, in. = 92.5	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 150.0	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. = 500.0	TRACK PITCH, in. = 6.03	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 60.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 57.0	ROLLING RESISTANCE,lb per ton= 100.0	PROPULSION MOTOR EFF,% =94.
STEER MOTOR EFF,% = 92.	STEER SYS. GEAR RATIO = 99:1	PROP. SYS. GEAR RATIO = 21:1

Efficiency data for Westinghouse induction motor by Craig Joseph 10-MAY-85

CONFIGURATION II
PROPULSION/STEER MOTOR SET-UP

RESULTS:

VEH. SPEED (mph)	LAT. ACCEL (gs)	TURN RADIUS (ft)	INNER SPROCKET APARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET APARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (lbft)	STEER MOTOR HP	STEER MOTOR RPM	STEER MOTOR TORQUE (lbft)	PROPULSION MOTOR HP	PROPULSION MOTOR RPM	PROPULSION MOTOR TORQUE (lbft)	SCRUB HP	TRANS HP
0.00	.0000	0.00	113.4	9.9	-60.9	-9783.3	113.5	9.9	60.9	9783.1	246.6	6064.9	213.5	0.0	0.3	0.0	103.5	0.0
1.50	.0740	2.03	93.2	8.3	-50.7	-9667.3	177.9	16.1	98.4	9496.2	295.6	7423.7	209.1	-0.8	503.6	-8.6	125.0	40.1
3.00	.1490	4.04	49.6	4.5	-27.3	-9554.5	217.1	20.1	122.8	9283.9	292.5	7473.5	205.6	-2.6	1007.3	-13.6	124.2	79.1
4.50	.2240	6.04	6.4	0.6	-3.6	-9443.5	254.7	24.0	146.8	9108.4	288.7	7490.1	202.5	-4.9	1510.9	-16.9	122.9	117.1
6.00	.2990	8.05	-29.3	3.3	20.2	-7614.0	291.2	28.0	170.8	8955.0	258.2	7498.4	180.8	25.9	2014.6	67.6	121.5	154.1
7.50	.3730	10.08	-63.2	7.3	44.3	-7502.4	326.5	31.9	194.5	8814.4	253.7	7483.3	178.1	31.7	2518.2	66.2	119.6	190.1
9.00	.4480	12.09	-95.8	11.2	68.1	-7393.3	361.3	35.9	218.5	8686.0	250.2	7489.9	175.5	37.5	3021.9	65.2	118.2	225.2
10.50	.5000	14.74	-131.5	15.7	95.2	-7251.3	388.2	39.4	239.1	8527.0	234.9	7165.1	172.2	43.2	3525.5	64.3	111.2	258.3
12.00	.5000	19.26	-171.1	21.1	128.1	-7016.3	400.2	41.9	254.0	8275.9	199.2	6269.5	166.9	48.7	4029.1	63.5	94.5	286.8
13.50	.5000	24.37	-204.6	26.3	159.0	-6758.1	413.3	44.8	270.9	8012.8	171.0	5572.9	161.2	54.6	4532.8	63.3	81.3	312.1
15.00	.5000	30.09	-232.5	31.3	188.4	-6479.3	426.0	48.0	289.2	7737.9	148.2	5015.6	155.2	60.9	5036.4	63.5	70.5	334.3
16.50	.5000	36.41	-255.3	36.1	216.9	-6182.7	437.7	51.4	308.5	7452.2	129.2	4559.6	148.8	67.6	5540.1	64.0	61.5	353.0
18.00	.5000	43.33	-273.4	40.9	244.6	-5871.3	447.7	55.0	328.5	7157.3	113.2	4179.6	142.2	74.6	6043.7	64.9	53.9	368.3
19.50	.5000	50.85	-287.0	45.6	271.7	-5548.1	455.8	58.6	349.2	6855.0	99.4	3858.1	135.4	82.2	6547.3	65.9	47.4	380.1

SPROCKET HORSEPOWER   RUN DATE:No. 7-AUG-85:3

VEH. SPEED (mph)	LAT. ACCEL (gs)	TURN RADIUS (ft)	INNER SPROCKET APARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET APARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (lbft)	STEER MOTOR HP	STEER MOTOR RPM	STEER MOTOR TORQUE (lbft)	PROPULSION MOTOR HP	PROPULSION MOTOR RPM	PROPULSION MOTOR TORQUE (lbft)	SCRUB HP	TRANS HP
21.00	.5000	58.98	-296.3	50.3	298.4	-5216.0	461.6	62.5	370.3	6547.3	87.6	3582.6	128.4	90.2	7051.0	67.2	41.8	388.4
22.50	.5000	67.70	-301.5	55.0	324.6	-4878.0	465.2	66.4	391.8	6236.4	77.2	3343.7	121.3	98.6	7554.6	68.5	36.9	393.4
24.00	.5000	77.03	-302.9	59.7	350.6	-4536.8	466.5	70.4	413.6	5924.6	68.1	3134.7	114.2	107.4	8058.3	70.0	32.5	395.1
25.50	.5000	86.96	-300.6	64.5	376.3	-4195.1	465.6	74.6	435.6	5614.1	60.1	2950.3	107.1	116.7	8561.9	71.6	28.7	393.8
27.00	.5000	97.49	-295.0	69.2	401.9	-3855.6	462.6	78.8	457.8	5307.0	53.1	2786.4	100.0	126.4	9065.6	73.2	25.4	389.6
28.50	.5000	108.62	-286.4	74.0	427.2	-3520.5	457.7	83.2	480.2	5005.3	46.8	2639.8	93.0	136.5	9569.2	74.9	22.4	382.7
30.00	.5000	120.36	-275.0	78.9	452.4	-3192.0	451.0	87.6	502.8	4710.7	41.2	2507.8	86.2	146.9	10072.8	76.6	19.7	373.5
31.50	.5000	132.70	-261.1	83.8	477.5	-2872.0	442.7	92.2	525.5	4425.1	36.2	2388.4	79.6	157.8	10576.5	78.3	17.3	362.2
33.00	.5000	145.63	-245.1	88.7	502.5	-2562.1	433.2	96.8	548.3	4149.7	31.8	2279.8	73.2	168.9	11080.1	80.1	15.2	349.1
34.50	.5000	159.18	-227.3	93.8	527.4	-2263.8	422.6	101.6	571.1	3885.9	27.9	2180.7	67.1	180.5	11583.8	81.8	13.3	334.4
36.00	.5000	173.32	-208.0	98.9	552.2	-1978.3	411.2	106.4	594.1	3634.7	24.4	2089.8	61.3	192.3	12087.4	83.6	11.7	318.6
37.50	.5000	188.06	-187.4	104.1	576.9	-1706.5	399.2	111.4	617.2	3396.9	21.3	2006.2	55.7	204.4	12591.0	85.3	10.2	301.7
39.00	.5000	203.41	-166.0	109.4	601.5	-1449.0	386.8	116.5	640.3	3173.0	18.5	1929.1	50.4	216.8	13094.7	87.0	8.9	284.2
40.50	.5000	219.35	-143.8	114.8	626.1	-1206.4	374.4	121.6	663.4	2963.6	16.1	1857.6	45.5	229.5	13598.3	88.6	7.7	266.3
42.00	.5000	235.90	-121.3	120.3	650.7	-978.9	362.0	126.9	686.6	2768.7	13.9	1791.3	40.9	242.4	14102.0	90.3	6.7	248.2
43.50	.5000	253.06	-98.5	125.9	675.2	-766.5	349.9	132.3	709.9	2588.5	12.1	1729.5	36.6	255.6	14605.6	91.9	5.8	230.2
45.00	.5000	270.81	-75.8	131.6	699.6	-569.2	338.2	137.9	733.2	2422.7	10.4	1671.9	32.7	269.0	15109.3	93.5	5.0	212.4

End

SPROCKET HORSEPOWER

BY: W.E. RODLER REV.DATE: 14 MAY 1985
L.M. FERNANDEZ

RUN DATE: 7-AUG-85:1

DATA INPUT:

GROSS VEHICLE WEIGHT, tons = 19.5	TREAD WIDTH, in. = 92.5	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 150.0	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. = 500.0	TRACK PITCH, in. = 6.03	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 60.0	NUMBER OF SPROCKET TEETH = 11	
FRONTAL AREA, in. = 57.0	ROLLING RESISTANCE,lb per ton= 100.0	COEFICIENT OF DRAG = 1.00

Efficiency data for Homopolar motor given by Gene Seider 20-MAY-85

CONCEPT I: TWIN PROPULSION MOTORS

RESULTS:

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	INNER SPROCKET APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (ftlbs)	OUTER SPROCKET APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
0.00	0.000	0.00	165.50	14.5	-88.8	-9783.3	165.56	14.5	88.88	9783.3	151.0	0.0
1.50	0.084	1.78	112.50	10.0	-61.0	-9681.4	200.54	17.8	108.79	9681.4	142.6	40.1
3.00	0.070	8.62	-18.21	2.1	12.6	-7584.7	146.84	13.5	82.91	9301.3	56.5	76.8
4.50	0.149	9.09	-31.11	3.5	21.6	-7558.6	214.90	19.9	121.67	9276.7	80.2	114.8
6.00	0.253	9.50	-45.53	5.2	31.7	-7535.1	280.73	26.1	159.31	9255.2	102.0	152.7
7.50	0.340	11.06	-72.24	8.4	50.9	-7449.7	328.12	30.8	187.88	9172.3	108.4	188.9
9.00	0.403	13.45	-105.50	12.4	75.7	-7321.2	363.26	34.6	210.88	9047.1	105.3	223.3
10.50	0.453	16.26	-139.22	16.8	102.0	-7172.1	393.85	38.3	232.38	8901.7	99.8	255.8
12.00	0.500	19.26	-171.14	21.1	128.1	-7016.1	423.13	41.9	253.98	8750.1	94.5	286.7
13.50	0.500	24.38	-204.56	26.3	159.0	-6757.8	438.20	44.8	270.87	8496.7	81.2	312.1
15.00	0.500	30.10	-232.48	31.3	188.5	-6479.0	452.73	48.0	289.15	8223.3	70.5	334.2
16.50	0.500	36.42	-255.34	36.1	216.9	-6182.4	465.89	51.4	308.46	7932.7	61.5	353.0
18.00	0.500	43.34	-273.43	40.9	244.6	-5870.9	477.14	55.0	328.52	7628.0	53.9	368.3
19.50	0.500	50.86	-287.01	45.6	271.7	-5547.7	486.12	58.6	349.18	7311.9	47.4	380.1

SPROCKET HORSEPOWER   RUN DATE;No. 7-AUG-85;1

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER TORQUE (ftlbs)	APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
21.00	0.500	58.99	-296.29	50.3	298.4	-5215.6	492.65	62.5	370.29	6987.6	41.8	388.4
22.50	0.500	67.72	-301.49	55.0	324.6	-4877.5	496.63	66.4	391.77	6657.8	36.9	393.4
24.00	0.500	77.05	-302.83	59.7	350.6	-4536.2	498.08	70.4	413.56	6325.6	32.5	395.1
25.50	0.500	86.98	-300.57	64.5	376.4	-4194.5	497.07	74.6	435.59	5993.4	28.7	393.7
27.00	0.500	97.51	-294.97	69.2	401.9	-3855.0	493.72	78.8	457.82	5663.9	23.3	389.5
28.50	0.500	108.65	-286.32	74.0	427.2	-3519.9	488.22	83.2	480.23	5339.5	22.3	382.7
30.00	0.500	120.38	-274.92	78.9	452.4	-3191.3	480.78	87.6	502.79	5022.2	19.7	373.5
31.50	0.500	132.72	-261.06	83.8	477.5	-2871.3	471.63	92.2	525.47	4714.0	17.3	362.1
33.00	0.500	145.66	-245.06	88.7	502.5	-2561.4	461.04	96.8	548.26	4416.6	15.2	349.0
34.50	0.500	159.21	-227.25	93.8	527.4	-2263.2	449.26	101.6	571.14	4131.3	13.3	334.4
36.00	0.500	173.35	-207.91	98.9	552.2	-1977.7	436.57	106.4	594.11	3859.3	11.7	318.5
37.50	0.500	188.10	-187.37	104.1	576.9	-1705.9	423.22	111.4	617.15	3601.7	10.2	301.7
39.00	0.500	203.45	-165.89	109.4	601.5	-1448.4	409.47	116.5	640.26	3358.9	8.9	284.2
40.50	0.486	225.46	-133.95	114.9	626.6	-1122.7	384.79	121.5	662.92	3048.6	7.2	256.0
42.00	0.465	253.66	-95.32	120.5	651.9	-767.9	353.60	126.7	685.38	2709.6	5.5	221.4
43.50	0.442	286.56	-55.11	126.2	677.2	-427.4	321.52	132.0	707.87	2385.5	4.1	185.5
45.00	0.415	326.13	-13.66	132.1	702.5	-102.1	288.87	137.3	730.36	2077.3	2.9	148.6

End

SPROCKET HORSEPOWER

BY: W.E. RODLER REV.DATE: 14 MAY 1985
L.M. FERNANDEZ

RUN DATE: 15-AUG-85:115

DATA INPUT:

GROSS VEHICLE WEIGHT, tons = 40.0
MAXIMUM VELOCITY, mph = 45.0
ENGINE GROSS HP. =1000.0
LOSS ENGINE HP. = 120.0
FRONTAL AREA, in. = 68.3

TREAD WIDTH, in. = 109.8
TRACK LENGTH, in. = 183.1
TRACK PITCH, in. = 7.63
NUMBER OF SPROCKET TEETH = 11
ROLLING RESISTANCE,lb per ton= 100.0

GRADE, % = 0.0
COEFFICIENT OF FRICTION = 0.70
MAXIMUM ACCELERATION, gs =0.50
COEFICIENT OF DRAG = 1.00

Efficiency .ata for Westinghouse induction motor * CONCEPT I: TWIN PROPULSION MOTORS
by Craig Joseph 10-MAY-85

RESULTS:

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	TORQUE (ftlbs)	APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
0.00	0.000	0.00	349.19	30.1	-71.2	-25773.	349.31	30.2	71.18	25773.3	319.1	0.1
1.50	0.069	2.17	235.50	20.6	-48.6	-25447.	418.50	36.6	86.38	25447.3	298.4	83.5
3.00	0.058	10.41	-36.58	4.1	9.7	-19794.	303.90	27.9	65.83	24245.0	117.7	158.4
4.50	0.123	11.01	-63.25	7.1	16.9	-19707.	443.71	40.9	96.45	24160.9	166.2	236.6
6.00	0.209	11.54	-93.05	10.6	24.9	-19631.	578.74	53.5	126.19	24088.2	210.8	314.4
7.50	0.286	13.16	-143.79	16.5	38.9	-19402.	681.19	63.7	149.93	23862.5	228.6	388.9
9.00	0.346	15.66	-207.94	24.4	57.3	-19054.	758.19	72.0	169.31	23519.9	227.0	459.3
10.50	0.399	18.46	-273.00	32.7	76.8	-18670.	826.56	79.9	187.60	23141.0	220.5	526.2
12.00	0.446	21.57	-336.72	41.3	96.9	-18251.	888.32	87.5	205.27	22729.1	211.4	589.4
13.50	0.493	24.72	-396.53	49.9	116.8	-17837.	948.50	95.3	223.17	22321.7	203.4	649.8
15.00	0.500	30.10	-458.07	60.0	140.3	-17148.	978.23	101.6	237.41	21641.4	179.3	697.4
16.50	0.500	36.42	-509.88	70.1	163.6	-16369.	1000.94	108.0	251.88	20871.4	156.5	736.5
18.00	0.500	43.34	-551.21	80.0	186.2	-15551.	1020.29	114.7	267.08	20063.6	137.2	768.4
19.50	0.500	50.86	-582.70	89.6	208.2	-14702.	1035.42	121.8	282.86	19225.7	120.6	793.0

SPROCKET HORSEPOWER RUN DATE;No. 15-AUG-85;115

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (ftlbs)	INNER SPROCKET APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
21.00	0.500	58.99	-604.90	99.2	229.7	-13830.	1045.80	129.1	299.07	18365.6	106.3	810.4
22.50	0.500	67.72	-618.33	108.6	250.9	-12943.	1051.19	136.7	315.65	17490.9	93.8	820.7
24.00	0.500	77.05	-623.52	118.0	271.8	-12048.	1051.53	144.4	332.51	16609.2	82.8	824.3
25.50	0.500	86.98	-621.03	127.4	292.5	-11152.	1046.92	152.3	349.61	15727.5	73.1	821.5
27.00	0.500	97.51	-611.45	136.8	313.0	-10261.	1037.59	160.4	366.91	14852.6	64.5	812.7
28.50	0.500	108.65	-595.40	146.2	333.3	-9383.	1023.90	168.6	384.37	13990.6	56.9	798.4
30.00	0.500	120.38	-573.52	155.6	353.4	-8523.	1006.25	177.0	401.98	13147.3	50.1	779.2
31.50	0.500	132.72	-546.48	165.1	373.5	-7685.	985.12	185.5	419.71	12327.5	44.0	755.6
33.00	0.500	145.66	-514.94	174.6	393.4	-6875.	961.03	194.2	437.54	11535.7	38.7	728.2
34.50	0.500	159.21	-479.57	184.2	413.3	-6095.	934.49	203.0	455.47	10775.8	33.9	697.6
36.00	0.500	173.35	-441.03	193.8	433.0	-5349.	906.07	211.9	473.48	10050.7	29.7	664.5
37.50	0.500	188.10	-399.96	203.5	452.7	-4640.	876.29	221.0	491.55	9362.9	25.9	629.4
39.00	0.500	203.45	-356.96	213.4	472.3	-3969.	845.67	230.2	509.69	8714.2	22.5	592.9
40.50	0.500	219.40	-312.62	223.3	491.9	-3338.	814.72	239.6	527.88	8105.9	19.6	555.5
42.00	0.500	235.95	-267.45	233.3	511.4	-2746.	783.89	249.2	546.13	7538.7	17.0	517.8
43.50	0.500	253.11	-221.94	243.5	530.9	-2195.	753.60	258.8	564.41	7012.6	14.7	480.1
45.00	0.500	2[illegible]0.86	-176.52	253.7	550.4	-1684.	724.24	268.7	582.74	6527.4	12.7	442.9

End

SPROCKET HORSEPOWER

BY: W.E. RODLER REV.DATE: 13 JUNE 1985
R.E. LEWIS

RUN DATE: 15-AUG-85:116

DATA INPUT:

GROSS VEHICLE WEIGHT, tons = 40.0
MAXIMUM VELOCITY, mph = 45.0
ENGINE GROSS HP. =1000.0
LOSS ENGINE HP. = 120.0
FRONTAL AREA, ft^2 = 68.3
STEER MOTOR EFF,% = 92.

TREAD WIDTH, in. = 109.8
TRACK LENGTH, in. = 183.1
TRACK PITCH, in. = 7.63
NUMBER OF SPROCKET TEETH = 11
ROLLING RESISTANCE,lb per ton= 100.0
STEER SYS. GEAR RATIO = 99:1

GRADE, % = 0.0
COEFFICIENT OF FRICTION = 0.70
MAXIMUM ACCELERATION, gs =0.50
COEFICIENT OF DRAG = 1.00
PROPULSION MOTOR EFF,% =94.
PROP. SYS. GEAR RATIO = 21:1

Efficiency data for Westinghouse induction motor
by Craig Joseph 10-MAY-85

CONFIGURATION II
PROPULSION/STEER MOTOR SET-UP

RESULTS:

VEH. SPEED (mph)	LAT. ACCEL (gs)	TURN RADIUS (ft)	INNER SPROCKET APARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET APARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (lbft)	STEER MOTOR HP	STEER MOTOR RPM	STEER MOTOR TORQUE (lbft)	PROPULSION MOTOR HP	PROPULSION MOTOR RPM	PROPULSION MOTOR TORQUE (lbft)	SCRUB HP	TRANS HP
0.00	.0000	0.00	288.1	24.9	-58.7	-25774.	288.2	24.9	58.7	25773.	626.4	5848.6	562.5	0.0	0.3	0.0	263.3	0.1
1.50	.0720	2.09	247.5	21.6	-51.0	-25459.	423.9	37.6	88.8	25064.	731.2	6965.5	551.4	-1.5	398.3	-19.9	309.4	83.5
3.00	.1470	4.09	161.1	14.2	-33.6	-25161.	509.8	46.3	109.2	24527.	734.1	7110.2	542.3	-4.9	796.6	-32.0	311.7	164.9
4.50	.2250	6.02	76.7	6.9	-16.2	-24880.	593.9	54.9	129.5	24087.	738.2	7255.2	534.4	-9.1	1194.9	-40.0	314.2	244.4
6.00	.3040	7.92	-6.6	0.7	1.7	-20149.	674.0	63.4	149.4	23700.	669.8	7351.9	478.5	54.3	1593.2	179.1	314.5	321.8
7.50	.3790	9.92	-78.7	8.8	20.8	-19859.	746.4	71.4	168.0	23327.	658.0	7332.5	471.3	66.3	1991.4	174.9	309.6	397.1
9.00	.4540	11.93	-148.4	16.9	39.8	-19573.	817.3	79.4	186.8	22980.	647.2	7319.5	464.4	78.2	2389.7	171.9	305.1	470.4
10.50	.5000	14.74	-229.4	26.7	62.8	-19178.	864.5	85.8	201.6	22525.	598.7	6909.6	455.1	89.6	2788.0	168.9	282.8	539.0
12.00	.5000	19.26	-319.4	38.5	90.4	-18560.	881.1	90.3	211.8	21851.	507.7	6045.9	441.0	100.7	3186.3	166.0	240.4	598.3
13.50	.5000	24.37	-395.0	49.5	116.0	-17882.	901.5	95.6	223.9	21145.	435.8	5374.1	425.9	112.3	3584.6	164.6	206.7	651.3
15.00	.5000	30.09	-458.1	60.0	140.3	-17149.	922.5	101.6	237.4	20408.	377.5	4836.7	409.9	124.7	3982.9	164.4	179.3	697.4
16.50	.5000	36.41	-509.9	70.1	163.6	-16370.	942.1	108.0	251.9	19644.	329.0	4397.0	393.0	137.8	4381.2	165.1	156.5	736.5
18.00	.5000	43.33	-551.2	80.0	186.2	-15552.	958.9	114.7	267.1	18856.	288.2	4030.6	375.5	151.7	4779.5	166.7	137.2	768.4
19.50	.5000	50.85	-582.7	89.6	208.2	-14704.	972.1	121.8	282.9	18049.	253.2	3720.5	357.4	166.4	5177.8	168.8	120.7	793.0

SPROCKET HORSEPOWER   RUN DATE:No. 15-AUG-85:116

VEH. SPEED (mph)	LAT. ACCEL (gs)	TURN RADIUS (ft)	INNER SPROCKET APARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET APARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (lbft)	STEER MOTOR HP	STEER MOTOR RPM	STEER MOTOR TORQUE (lbft)	PROPULSION MOTOR HP	PROPULSION MOTOR RPM	PROPULSION MOTOR TORQUE (lbft)	SCRUB HP	TRANS HP
21.00	.5000	58.98	-605.0	99.2	229.7	-13832.	981.1	129.1	299.1	17229.	223.0	3454.8	339.0	181.9	5576.1	171.3	106.3	810.5
22.50	.5000	67.70	-618.4	108.6	250.9	-12945.	985.6	136.7	315.7	16400.	196.6	3224.5	320.2	198.3	5974.3	174.3	93.8	820.8
24.00	.5000	77.03	-623.6	118.0	271.8	-12049.	985.7	144.4	332.5	15569.	173.5	3022.9	301.4	215.4	6372.6	177.5	82.8	824.4
25.50	.5000	86.96	-621.1	127.4	292.5	-11153.	981.3	152.3	349.6	14742.	153.1	2845.1	282.6	233.4	6770.9	181.0	73.1	821.6
27.00	.5000	97.49	-611.6	136.8	313.0	-10263.	972.7	160.4	366.9	13924.	135.0	2687.0	264.0	252.0	7169.2	184.6	64.5	812.9
28.50	.5000	108.62	-595.5	146.2	333.3	-9385.	960.2	168.6	384.4	13120.	119.0	2545.6	245.6	271.4	7567.5	188.4	56.9	798.6
30.00	.5000	120.36	-573.6	155.6	353.4	-8525.	944.1	177.0	402.0	12335.	104.8	2418.3	227.6	291.5	7965.8	192.2	50.1	779.3
31.50	.5000	132.70	-546.6	165.1	373.5	-7687.	924.8	185.5	419.7	11573.	92.2	2303.2	210.2	312.2	8364.1	196.0	44.1	755.7
33.00	.5000	14[illegible].63	-515.1	174.6	393.4	-6877.	902.9	194.2	437.5	10838.	80.9	2198.5	193.3	333.4	8762.4	199.8	38.7	728.3
34.50	.5000	159.18	-479.7	184.1	413.2	-6097.	878.8	203.0	455.5	10134.	70.9	2102.9	177.1	355.2	9160.7	203.6	33.9	697.8
36.00	.5000	173.32	-441.2	193.8	433.0	-5351.	853.1	211.9	473.5	9463.	62.0	2015.3	161.7	377.5	9559.0	207.4	29.7	664.7
37.50	.5000	188.06	-400.1	203.5	452.7	-4642.	826.1	221.0	491.6	8827.	54.1	1934.7	147.0	400.2	9957.2	211.1	25.9	629.6
39.00	.5000	203.41	-357.1	213.4	472.3	-3971.	798.4	230.2	509.7	8227.	47.2	1860.3	133.1	423.3	10355.5	214.7	22.6	593.1
40.50	.5000	219.35	-312.8	223.3	491.9	-3339.	770.4	239.6	527.9	7665.	41.0	1791.4	120.1	446.8	10753.8	218.2	19.6	555.7
42.00	.5000	235.90	-267.6	233.3	511.4	-2748.	742.6	249.2	546.1	7142.	35.5	1727.4	107.9	470.6	11152.1	221.6	17.0	517.9
43.50	.5000	253.06	-222.1	243.5	530.9	-2197.	715.4	258.8	564.4	6657.	30.7	1667.8	96.6	494.7	11550.4	225.0	14.7	480.3
45.00	.5000	270.81	-176.7	253.7	550.4	-1686.	689.0	268.7	582.7	6209.	26.4	1612.2	86.2	519.1	11948.7	228.2	12.7	443.1

End

SPROCKET HORSEPOWER

BY: W.E. RODLER REV.DATE: 14 MAY 1985
L.M. FERNANDEZ

RUN DATE: 15-AUG-85:114

DATA INPUT:

GROSS VEHICLE WEIGHT, tons = 40.0
MAXIMUM VELOCITY, mph = 45.0
ENGINE GROSS HP. =1000.0
LOSS ENGINE HP. = 120.0
FRONTAL AREA, in. = 68.3

TREAD WIDTH, in. = 109.8
TRACK LENGTH, in. = 183.1
TRACK PITCH, in. = 7.63
NUMBER OF SPROCKET TEETH = 11
ROLLING RESISTANCE,lb per ton= 100.0

GRADE, % = 0.0
COEFFICIENT OF FRICTION = 0.70
MAXIMUM ACCELERATION, gs =0.50
COEFICIENT OF DRAG = 1.00

Efficiency data for Homopolar motor given by Gene Seider 20-MAY-85

CONCEPT I: TWIN PROPULSION MOTORS

RESULTS:

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (ftlbs)	APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
0.00	0.000	0.00	330.32	28.5	-67.3	-25773.	330.44	28.5	67.34	25773.3	301.9	0.1
1.50	0.066	2.28	219.38	19.2	-45.3	-25431.	402.26	35.2	83.08	25430.6	283.6	83.4
3.00	0.057	10.63	-38.72	4.4	10.3	-19762.	300.83	27.7	65.25	24213.6	115.0	158.1
4.50	0.120	11.24	-66.17	7.5	17.7	-19675.	439.42	40.6	95.65	24128.7	162.6	236.3
6.00	0.205	11.75	-96.21	10.9	25.8	-19603.	574.01	53.2	125.31	24059.3	206.9	314.0
7.50	0.271	13.89	-153.69	17.8	41.8	-19301.	665.20	62.4	147.03	23761.6	215.7	387.1
9.00	0.321	16.85	-220.40	26.0	61.3	-18892.	735.34	70.3	165.35	23357.1	209.3	455.7
10.50	0.364	20.27	-286.78	34.8	81.7	-18428.	796.38	77.7	182.66	22898.8	198.5	520.1
12.00	0.404	23.83	-348.80	43.5	102.0	-17956.	854.86	85.3	200.14	22433.3	188.6	580.9
13.50	0.440	27.71	-407.10	52.3	122.5	-17453.	908.17	92.8	217.43	21937.8	178.0	637.4
15.00	0.468	32.17	-461.26	61.4	143.4	-16890.	953.83	100.2	234.27	21383.6	165.5	688.1
16.50	0.492	37.01	-509.86	70.4	164.3	-16297.	994.70	107.7	251.17	20800.0	153.4	733.7
18.00	0.500	43.34	-551.21	80.0	186.2	-15551.	1020.29	114.7	267.08	20063.6	137.2	768.4
19.50	0.500	50.36	-582.70	89.6	208.2	-14702.	1035.42	121.8	282.86	19225.7	120.6	793.0

SPROCKET HORSEPOWER   RUN DATE:No. 15-AUG-85;114

VEH SPEED (mph)	LATERAL ACCEL (gs)	TURN RADIUS (ft)	APPARNT HP	INNER SPROCKET PROP HP	INNER SPROCKET RPM	INNER SPROCKET TORQUE (ftlbs)	INNER SPROCKET APPARNT HP	OUTER SPROCKET PROP HP	OUTER SPROCKET RPM	OUTER SPROCKET TORQUE (ftlbs)	SCRUB HP	TRANSFR HP
21.00	0.500	58.99	-604.90	99.2	229.7	-13830.	1045.80	129.1	299.07	18365.6	106.3	810.4
22.50	0.500	67.72	-618.33	108.6	250.9	-12943.	1051.19	136.7	315.65	17490.9	93.8	820.7
24.00	0.500	77.05	-623.52	118.0	271.8	-12048.	1051.53	144.4	332.51	16609.2	82.8	824.3
25.50	0.500	86.98	-621.03	127.4	292.5	-11152.	1046.92	152.3	349.61	15727.5	73.1	821.5
27.00	0.500	97.51	-611.45	136.8	313.0	-10261.	1037.59	160.4	366.91	14852.6	64.5	812.7
28.50	0.500	108.65	-595.40	146.2	333.3	-9383.	1023.90	168.6	384.37	13990.6	56.9	798.4
30.00	0.500	120.38	-573.52	155.6	353.4	-8523.	1006.25	177.0	401.98	13147.3	50.1	779.2
31.50	0.500	132.72	-546.48	165.1	373.5	-7685.	985.12	185.5	419.71	12327.5	44.0	755.6
33.00	0.500	145.66	-514.94	174.6	393.4	-6875.	961.03	194.2	437.54	11535.7	38.7	728.2
34.50	0.500	159.21	-479.57	184.2	413.3	-6095.	934.49	203.0	455.47	10775.8	33.9	697.6
36.00	0.500	173.35	-441.03	193.8	433.0	-5349.	906.07	211.9	473.48	10050.7	29.7	664.5
37.50	0.500	188.10	-399.96	203.5	452.7	-4640.	876.29	221.0	491.55	9362.9	25.9	629.4
39.00	0.500	203.45	-356.96	213.4	472.3	-3969.	845.67	230.2	509.69	8714.2	22.5	592.9
40.50	0.500	219.40	-312.62	223.3	491.9	-3338.	814.72	239.6	527.88	8105.9	19.6	555.5
42.00	0.497	237.11	-263.76	233.4	511.5	-2708.	779.79	249.1	546.04	7500.4	16.8	513.9
43.50	0.483	261.81	-196.75	243.7	531.5	-1944.	725.89	258.6	563.86	6761.4	13.4	453.9
45.00	0.467	289.79	-127.33	254.2	551.4	-1213.	670.68	268.2	581.68	6055.6	10.5	392.0

End

B.2.D Gear Speeds And Loads at Maximum Turn Conditions

The following tables provide the torque and speed data for all gears during maximum turn conditions. These tables are divided into the same three divisions as the previous tables. The Title Heading and the inputs are the same as the previous section. The data format facilitates analysis by placing speeds and torques of each component in adjacent positions.

The first row of the results section lists the components by name or by identification letter shown on the gear configuration diagrams. The next segment defines the data arrangement; typically RPM above a dotted line and torque in pound-feet immediately below. The data output is immediately below, with horizontal dotted lines for each 1.5 MPH increment, and corresponding and speeds and torques above and below the dotted line.

GEAR LOADS AT MAXIMUM TURN CONDITION   BY: RICK LEWIS;   REVISION: 16-JUL-85
RUN DATE: 20-AUG-85;5

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5	TREAD WIDTH, in. = 92.5	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 150.0	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. = 500.0	TRACK PITCH, in. = 6.03	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 60.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 57.0	ROLLING RESISTANCE,lb per ton= 100.0	

Efficiency data for Westinghouse induction motor   ALTERNATIVE I
by Craig Joseph 10-MAY-85   TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
0.0	-94.	94.	1840.	1839.	-604.	604.	-166.	166.	435.	-435.	-94.	94.
	-9783.	9783.	496.	-495.	-1551.	1651.	-5547.	5547.	530.	-530.	-8665.	8664.
	-66.	114.	2218.	1285.	-728.	422.	-200.	116.	524.	-304.	-66.	114.
	-9687.	9687.	491.	-490.	-1634.	1634.	-5492.	5492.	524.	-524.	-8579.	8578.
	12.	83.	1630.	236.	-535.	-78.	-147.	-21.	385.	56.	12.	83.
	-7592.	9308.	471.	-384.	-1570.	1281.	-5278.	4304.	504.	-411.	-6527.	8439.
4.5	21.	122.	2390.	410.	-785.	-135.	-216.	-37.	565.	97.	21.	122.
	-7565.	9283.	470.	-383.	-1566.	1276.	-5264.	4289.	502.	-409.	-6503.	8417.
6.0	31.	160.	3127.	606.	-1027.	-199.	-282.	-55.	739.	143.	31.	160.
	-7541.	9261.	469.	-382.	-1562.	1272.	-5251.	4276.	501.	-408.	-6482.	8398.
7.5	47.	192.	3749.	918.	-1231.	-301.	-338.	-83.	886.	217.	47.	192.
	-7482.	9205.	466.	-379.	-1553.	1262.	-5219.	4242.	498.	-405.	-6429.	8348.
9.0	70.	216.	4224.	1376.	-1387.	-452.	-381.	-124.	999.	325.	70.	216.
	-7373.	9099.	461.	-373.	-1535.	1244.	-5159.	4181.	492.	-399.	-6332.	8255.

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 20-AUG-85:5

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
10.5	95.	239.	4672.	1861.	-1534.	-611.	-422.	-168.	1104.	440.	95.	239.
	-7251.	8981.	455.	-367.	-1515.	1223.	-5092.	4112.	486.	-392.	-6224.	8151.
12.0	128.	254.	4963.	2503.	-1630.	-822.	-448.	-226.	1173.	592.	128.	254.
	-7016.	8750.	443.	-355.	-1476.	1184.	-4961.	3978.	474.	-380.	-6016.	7947.
13.5	159.	271.	5293.	3107.	-1738.	-1020.	-478.	-280.	1251.	734.	159.	271.
	-6758.	8497.	430.	-342.	-1434.	1140.	-4818.	3832.	460.	-366.	-5786.	7723.
15.0	188.	289.	5651.	3683.	-1856.	-1209.	-510.	-332.	1336.	870.	188.	289.
	-6479.	8224.	417.	-328.	-1387.	1093.	-4663.	3674.	445.	-351.	-5539.	7482.
	217.	308.	6028.	4239.	-1979.	-1392.	-544.	-383.	1425.	1002.	217.	308.
	-6183.	7933.	402.	-313.	-1338.	1043.	-4498.	3506.	429.	-335.	-5276.	7225.
	245.	329.	6420.	4780.	-2108.	-1570.	-579.	-431.	1517.	1130.	245.	329.
	-5871.	7628.	386.	-297.	-1287.	991.	-4325.	3329.	413.	-318.	-4999.	6956.
19.5	272.	349.	6824.	5310.	-2241.	-1744.	-616.	-479.	1613.	1255.	272.	349.
	-5548.	7312.	370.	-281.	-1234.	936.	-4146.	3146.	396.	-300.	-4712.	6677.
21.0	298.	370.	7236.	5830.	-2376.	-1915.	-653.	-526.	1710.	1378.	298.	370.
	-5216.	6988.	354.	-264.	-1179.	880.	-3962.	2958.	378.	-282.	-4417.	6391.
22.5	325.	392.	7656.	6344.	-2514.	-2083.	-691.	-573.	1810.	1500.	325.	392.
	-4878.	6658.	337.	-247.	-1123.	823.	-3775.	2766.	360.	-264.	-4117.	6100.
24.0	351.	414.	8082.	6852.	-2554.	-2250.	-729.	-618.	1910.	1620.	351.	414.
	-4537.	6326.	320.	-230.	-1067.	765.	-3587.	2572.	342.	-246.	-3813.	5807.
25.5	376.	436.	8512.	7354.	-2795.	-2415.	-768.	-664.	2012.	1738.	376.	436.
	-4195.	5994.	304.	-212.	-1011.	708.	-3399.	2379.	324.	-227.	-3510.	5514.
27.0	402.	458.	8947.	7853.	-2938.	-2579.	-807.	-709.	2115.	1856.	402.	458.
	-3856.	5664.	287.	-195.	-956.	650.	-3212.	2186.	307.	-209.	-3208.	5223.

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 20-AUG-85:5

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
28.5	427.	480.	9385.	8349.	-3082.	-2742.	-847.	-753.	2218.	1973.	427.	480.
	-3520.	5340.	270.	-178.	-901.	594.	-3028.	1996.	289.	-191.	-2910.	4937.
30.0	452.	503.	9825.	8841.	-3227.	-2903.	-887.	-798.	2322.	2090.	452.	503.
	-3192.	5023.	254.	-162.	-847.	539.	-2848.	1810.	272.	-173.	-2618.	4657.
31.5	478.	525.	10269.	9331.	-3372.	-3064.	-927.	-842.	2427.	2206.	478.	525.
	-2872.	4715.	239.	-145.	-795.	485.	-2673.	1628.	255.	-155.	-2333.	4386.
33.0	502.	548.	10714.	9819.	-3518.	-3225.	-967.	-886.	2532.	2321.	502.	548.
	-2562.	4417.	224.	-130.	-745.	432.	-2505.	1453.	239.	-139.	-2057.	4124.
5	527.	571.	11161.	10305.	-3665.	-3384.	-1007.	-930.	2638.	2436.	527.	571.
	-2264.	4132.	209.	-115.	-697.	382.	-2343.	1284.	224.	-123.	-1791.	3873.
	552.	594.	11610.	10790.	-3813.	-3543.	-1048.	-974.	2744.	2550.	552.	594.
	-1978.	3860.	196.	-100.	-651.	334.	-2189.	1122.	209.	-107.	-1537.	3634.
37.5	577.	617.	12060.	11273.	-3960.	-3702.	-1088.	-1017.	2851.	2665.	577.	617.
	-1706.	3602.	182.	-86.	-608.	288.	-2043.	968.	195.	-92.	-1295.	3407.
39.0	602.	640.	12512.	11755.	-4109.	-3860.	-1129.	-1061.	2957.	2778.	602.	640.
	-1449.	3360.	170.	-73.	-567.	244.	-1905.	822.	182.	-78.	-1065.	3194.
40.5	626.	663.	12964.	12236.	-4257.	-4018.	-1170.	-1104.	3064.	2892.	626.	663.
	-1206.	3132.	159.	-61.	-528.	204.	-1776.	684.	170.	-65.	-848.	2994.
42.0	651.	687.	13418.	12715.	-4406.	-4176.	-1211.	-1148.	3172.	3005.	651.	687.
	-979.	2921.	148.	-50.	-493.	165.	-1656.	555.	158.	-53.	-645.	2809.
43.5	675.	710.	13873.	13194.	-4556.	-4333.	-1252.	-1191.	3279.	3119.	675.	710.
	-766.	2725.	138.	-39.	-460.	129.	-1545.	435.	147.	-41.	-455.	2637.
45.0	700.	733.	14328.	13672.	-4705.	-4490.	-1293.	-1234.	3387.	3232.	700.	733.
	[illegible]9.	2544.	129.	-29.	-429.	[illegible].	-1443.	323.	138.	-31.	-27[illegible]	2479.

GEAR LOADS AT MAXIMUM TURN CONDITION   BY: RICK LEWIS: REVISION: 8-JUN-85
RUN DATE: 7-AUG-85:6

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5	TREAD WIDTH, in. = 92.5	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 150.0	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. = 500.0	TRACK PITCH, in. = 6.03	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 60.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 57.0	ROLLING RESISTANCE,lb per ton= 100.0	PROPULSION MOTOR EFF,% =94.
STEER MOTOR EFF,% = 92.	STEER SYS. GEAR RATIO = 99:1	PROP. SYS. GEAR RATIO = 21:1

Efficiency data for Westinghouse induction motor by Craig Joseph 10-MAY-85

ALTERNATIVE II
PROPULSION/STEER MOTOR SET-UP

MAX VEH MPH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
MPH	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
0.0	-81.	81.	0.	-1228.	1228.	470.	-470.	323.	-323.	-161.	161.	0.	0.	8038.	-2456.	0.	1525.	-398.
	-9783.	9783.	0.	487.	-487.	5089.	-5089.	2446.	-2446.	-815.	815.	-7337.	7337.	214.	-175.	-912.	1126.	4309.
1.5	-68.	116.	504.	-1096.	1712.	538.	-538.	465.	-274.	-232.	137.	0.	0.	9190.	-2808.	0.	1743.	-455.
	-9689.	9544.	-7.	482.	-476.	5002.	-5002.	2386.	-2422.	-795.	807.	-7158.	7267.	210.	-172.	-897.	1107.	4236.
3.0	-46.	142.	1007.	-812.	2044.	547.	-547.	566.	-184.	-283.	92.	0.	0.	9347.	-2856.	0.	1773.	-463.
	-9600.	9364.	-12.	477.	-467.	4932.	-4932.	2341.	-2400.	-780.	800.	-7023.	7200.	207.	-169.	-884.	1091.	4177.
4.5	-24.	167.	1511.	-529.	2376.	556.	-556.	668.	-95.	-334.	48.	0.	0.	9507.	-2905.	0.	1803.	-471.
	-9515.	9218.	-15.	473.	-460.	4872.	-4872.	2304.	-2379.	-768.	793.	-6913.	7136.	204.	-167.	-873.	1078.	4126.
6.0	-1.	193.	2015.	-245.	2707.	565.	-565.	770.	-6.	-385.	3.	0.	0.	9662.	-2952.	0.	1832.	-479.
	-9433.	9093.	-17.	468.	-454.	4818.	-4818.	2273.	-2358.	-758.	786.	-6820.	7075.	202.	-165.	-864.	1066.	4080.
7.5	23.	216.	2518.	74.	3004.	561.	-561.	863.	93.	-431.	-46.	0.	0.	9589.	-2930.	0.	1819.	-475.
	-7623.	8970.	68.	385.	-441.	4315.	-4315.	2242.	-1906.	-747.	635.	-6727.	5717.	181.	-148.	-774.	955.	3654.
9.0	59.	227.	3022.	570.	3124.	489.	-489.	909.	237.	-454.	-119.	0.	0.	8359.	-2554.	0.	1585.	-414.
	-7460.	8766.	66.	377.	-431.	4220.	-4220.	2192.	-1865.	-731.	622.	-6575.	5595.	177.	-145.	-757.	934.	3574.

GEAR LOADS AT MAXIMUM TURN CONDITION   RUN DATE:No. 7-AUG-85:6

MAX VEH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
MPH	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
10.5	95.	239.	3525.	1060.	3249.	419.	-419.	956.	381.	-478.	-190.	0.	0.	7165.	-2189.	0.	1359.	-355.
	-7251.	8527.	64.	367.	-419.	4104.	-4104.	2132.	-1813.	-711.	604.	-6395.	5438.	172.	-141.	-736.	908.	3475.
12.0	128.	254.	4029.	1504.	3420.	367.	-367.	1016.	512.	-508.	-256.	0.	0.	6269.	-1916.	0.	1189.	-311.
	-7016.	8276.	64.	355.	-407.	3977.	-3977.	2069.	-1754.	-690.	585.	-6207.	5262.	167.	-137.	-713.	880.	3368.
13.5	159.	271.	4533.	1919.	3621.	326.	-326.	1084.	636.	-542.	-318.	0.	0.	5573.	-1703.	0.	1057.	-276.
	-6758.	8013.	63.	342.	-394.	3842.	-3842.	2003.	-1690.	-668.	563.	-6010.	5069.	161.	-132.	-689.	850.	3253.
15.0	188.	289.	5036.	2312.	3844.	293.	-293.	1157.	754.	-578.	-377.	0.	0.	5016.	-1533.	0.	951.	-249.
	-6479.	7738.	63.	328.	-380.	3698.	-3698.	1934.	-1620.	-645.	540.	-5803.	4859.	155.	-127.	-663.	818.	3131.
16.5	217.	308.	5540.	2689.	4082.	267.	-267.	1234.	868.	-617.	-434.	0.	0.	4560.	-1393.	0.	865.	-226.
	-6183.	7452.	64.	313.	-366.	3546.	-3546.	1863.	-1546.	-621.	515.	-5589.	4637.	149.	-122.	-636.	785.	3003.
18.0	245.	329.	6044.	3055.	4332.	245.	-245.	1314.	978.	-657.	-489.	0.	0.	4180.	-1277.	0.	793.	-207.
	-5871.	7157.	65.	298.	-351.	3388.	-3388.	1789.	-1468.	-596.	489.	-5368.	4403.	142.	-116.	-607.	750.	2869.
19.5	272.	349.	6547.	3412.	4591.	226.	-226.	1397.	1087.	-698.	-543.	0.	0.	3858.	-1179.	0.	732.	-191.
	-5548.	6855.	66.	282.	-336.	3226.	-3226.	1714.	-1387.	-571.	462.	-5141.	4161.	135.	-111.	-578.	714.	2732.
21.0	298.	370.	7051.	3762.	4856.	210.	-210.	1481.	1193.	-741.	-597.	0.	0.	3583.	-1095.	0.	679.	-178.
	-5216.	6547.	67.	265.	-320.	3059.	-3059.	1637.	-1304.	-546.	435.	-4910.	3912.	128.	-105.	-548.	677.	2591.
22.5	325.	392.	7555.	4106.	5128.	196.	-196.	1567.	1299.	-784.	-649.	0.	0.	3344.	-1022.	0.	634.	-166.
	-4878.	6236.	69.	249.	-305.	2891.	-2891.	1559.	-1219.	-520.	406.	-4677.	3658.	121.	-99.	-518.	640.	2448.
24.0	351.	414.	8058.	4446.	5403.	183.	-183.	1654.	1402.	-827.	-701.	0.	0.	3135.	-958.	0.	595.	-155.
	-4537.	5925.	70.	232.	-289.	2721.	-2721.	1481.	-1134.	-494.	378.	-4443.	3403.	114.	-93.	-488.	602.	2304.
25.5	376.	436.	8562.	4782.	5683.	173.	-173.	1742.	1505.	-871.	-753.	0.	0.	2950.	-902.	0.	560.	-146.
	-4195.	5614.	72.	215.	-274.	2551.	-2551.	1404.	-1049.	-468.	350.	-4211.	3146.	107.	-88.	-457.	564.	2160.
27.0	402.	458.	9066.	5114.	5966.	163.	-163.	1831.	1607.	-916.	-804.	0.	0.	2786.	-851.	0.	528.	-138.
	-3856.	5307.	73.	198.	-258.	2383.	-2383.	1327.	-964.	-442.	321.	-3980.	2892.	100.	-82.	-427.	527.	2018.

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 7-AUG-95:6

MAX VEH MPH	Unit	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER 8	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
28.5	RPM	427.	480.	9569.	5445.	6251.	154.	-154.	1921.	1709.	-960.	-854.	0.	0.	2640.	-807.	0.	501.	-131.
	TORQUE ftxlbs	-3520.	5005.	75.	182.	-243.	2217.	-2217.	1251.	-880.	-417.	293.	-3754.	2640.	93.	-76.	-398.	491.	1878.
30.0	RPM	452.	503.	10073.	5772.	6539.	147.	-147.	2011.	1810.	-1006.	-905.	0.	0.	2508.	-766.	0.	476.	-124.
	TORQUE ftxlbs	-3192.	4711.	77.	165.	-228.	2055.	-2055.	1178.	-798.	-393.	266.	-3533.	2394.	86.	-71.	-368.	455.	1741.
31.5	RPM	478.	525.	10576.	6099.	6828.	140.	-140.	2102.	1910.	-1051.	-955.	0.	0.	2388.	-730.	0.	453.	-118.
	TORQUE ftxlbs	-2872.	4425.	78.	150.	-214.	1898.	-1898.	1106.	-718.	-369.	239.	-3319.	2154.	80.	-65.	-340.	420.	1607.
33.0	RPM	502.	548.	11080.	6423.	7119.	133.	-133.	2193.	2010.	-1097.	-1005.	0.	0.	2280.	-697.	0.	432.	-113.
	TORQUE ftxlbs	-2562.	4150.	80.	134.	-200.	1746.	-1746.	1037.	-541.	-346.	214.	-3112.	1922.	73.	-60.	-313.	386.	1478.
34.5	RPM	527.	571.	11584.	6746.	7412.	128.	-128.	2285.	2109.	-1142.	-1055.	0.	0.	2181.	-666.	0.	414.	-108.
	TORQUE ftxlbs	-2264.	3886.	82.	120.	-187.	1599.	-1599.	971.	-566.	-324.	189.	-2914.	1698.	67.	-55.	-287.	354.	1354.
36.0	RPM	552.	594.	12087.	7067.	7706.	122.	-122.	2376.	2209.	-1188.	-1104.	0.	0.	2090.	-639.	0.	396.	-104.
	TORQUE ftxlbs	-1978.	3635.	84.	106.	-174.	1460.	-1460.	909.	-495.	-303.	165.	-2726.	1484.	61.	-50.	-262.	323.	1236.
37.5	RPM	577.	617.	12591.	7388.	8001.	117.	-117.	2469.	2307.	-1234.	-1154.	0.	0.	2006.	-613.	0.	381.	-99.
	TORQUE ftxlbs	-1706.	3397.	85.	92.	-162.	1327.	-1327.	849.	-427.	-283.	142.	-2548.	1280.	56.	-46.	-238.	294.	1124.
39.0	RPM	602.	640.	13095.	7708.	8297.	113.	-113.	2561.	2406.	-1281.	-1203.	0.	0.	1929.	-589.	0.	366.	-96.
	TORQUE ftxlbs	-1449.	3173.	87.	80.	-151.	1202.	-1202.	793.	-362.	-264.	121.	-2380.	1087.	50.	-41.	-216.	266.	1018.
40.5	RPM	626.	663.	13598.	8026.	8594.	109.	-109.	2654.	2505.	-1327.	-1252.	0.	0.	1858.	-568.	0.	352.	-92.
	TORQUE ftxlbs	-1206.	2964.	89.	68.	-140.	1085.	-1085.	741.	-302.	-247.	101.	-2223.	905.	46.	-37.	-194.	240.	918.
42.0	RPM	651.	687.	14102.	8344.	8892.	105.	-105.	2747.	2603.	-1373.	-1301.	0.	0.	1791.	-547.	0.	340.	-89.
	TORQUE ftxlbs	-979.	2769.	90.	56.	-130.	975.	-975.	692.	-245.	-231.	82.	-2077.	734.	41.	-33.	-175.	216.	825.
43.5	RPM	675.	710.	14606.	8661.	9190.	101.	-101.	2840.	2701.	-1420.	-1350.	0.	0.	1730.	-528.	0.	328.	-86.
	TORQUE ftxlbs	-767.	2588.	92.	46.	-121.	873.	-873.	647.	-192.	-216.	64.	-1941.	575.	37.	-30.	-156.	193.	739.
45.0	RPM	700.	733.	15109.	8978.	9489.	98.	-98.	2933.	2799.	-1466.	-1399.	0.	0.	1672.	-511.	0.	317.	-83.
	TORQUE ftxlbs	-569.	2423.	93.	36.	-113.	778.	-778.	606.	-142.	-202.	47.	-1817.	427.	33.	-27.	-140.	172.	659.

End

GEAR LOADS AT MAXIMUM TURN CONDITION   BY: RICK LEWIS: REVISION: 16-JUL-85
RUN DATE: 7-AUG-85:4

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5	TREAD WIDTH, in. = 92.5	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 150.0	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. = 500.0	TRACK PITCH, in. = 6.03	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 60.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 57.0	ROLLING RESISTANCE,lb per ton= 100.0	

Efficiency data for Homopolar motor   CONFIGURATION I
by Gene Siedler 20-MAY-85   TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM	OUTER SPROK RPM	INNER MOTOR RPM	OUTER MOTOR RPM	INNER A RPM	OUTER A RPM	INNER B RPM	OUTER B RPM	INNER C RPM	OUTER C RPM	INNER D RPM	OUTER D RPM	INNER E RPM	OUTER E RPM	INNER F RPM	OUTER F RPM	INNER G RPM	OUTER G RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
0.0	-89.	89.	-1861.	1862.	2127	-2127	-677.	677.	891.	-891.	0.	0.	-245.	245.	323.	-323.	0.	0.
	-9783.	9783.	467.	-467.	136.	-136.	-1284.	1284.	2928.	-2928.	2260.	-2260.	-3545.	3545.	16164.	-16163	6239.	-6239.
1.5	-61.	109.	-1278.	2279.	1461	-2604	-465.	829.	612.	-1090.	0.	0.	-168.	300.	222.	-395.	0.	0.
	-9681.	9581.	462.	-462.	135.	-135.	-1271.	1271.	2898.	-2898.	2237.	-2237.	-3508.	3508.	15995.	-15995	6174.	-6174.
3.0	13.	83.	264.	1737.	-301	-1985	96.	632.	-126.	-831.	0.	0.	35.	229.	-46.	-301.	0.	0.
	-7585.	9301.	444.	-362.	106.	-130.	-996.	1221.	2270.	-2784.	1752.	-2149.	-2748.	3370.	12531.	-15367	4837.	-5931.
4.5	22.	122.	453.	2549.	-517	-2912	165.	927.	-217.	-1219.	0.	0.	60.	336.	-78.	-442.	0.	0.
	-7559.	9277.	443.	-361.	105.	-129.	-992.	1218.	2262.	-2777.	1746.	-2143.	-2739.	3361.	12488.	-15326	4820.	-5916.
6.0	32.	159.	665.	3337.	-759	-3814	242.	1214.	-318.	-1597.	0.	0.	88.	440.	-115.	-579.	0.	0.
	-7535.	9255.	442.	-360.	105.	-129.	-989.	1215.	2255.	-2770.	1741.	-2138.	-2730.	3353.	12449.	-15291	4805.	-5902.
7.5	51.	188.	1067.	3936.	-1219	-4498	388.	1431.	-510.	-1883.	0.	0.	141.	519.	-185.	-682.	0.	0.
	-7450.	9172.	438.	-356.	104.	-128.	-978.	1204.	2230.	-2745.	1721.	-2119.	-2699.	3323.	12308.	-15154	4751.	-5849.
9.0	76.	211.	1585.	4418.	-1811	-5048	577.	1605.	-759.	-2114.	0.	0.	209.	582.	-275.	-766.	0.	0.
	-7321.	9047.	432.	-349.	102.	-126.	-961.	1188.	2191.	-2708.	1692.	-2090.	-2653.	3278.	12096.	-14947	4669.	-5769.

GEAR LOADS AT MAXIMUM TURN CONDITION   RUN DATE:No. 7-AUG-85:4

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
10.5	102.	232.	2136.	4868.	-2440	-5563	777.	1770.	-1022.	-2329.	0.	0.	281.	641.	-370.	-844.	0.	0.
	-7172.	8902.	425.	-342.	100.	-124.	-942.	1169.	2147.	-2664.	1657.	-2057.	-2599.	3225.	11850.	-14707	4574.	-5676.
12.0	128.	254.	2683.	5321.	-3066	-6080	976.	1935.	-1284.	-2546.	0.	0.	354.	701.	-465.	-922.	0.	0.
	-7016.	8750.	418.	-335.	98.	-122.	-921.	1149.	2100.	-2619.	1621.	-2022.	-2542.	3170.	11592.	-14456	4474.	-5580.
13.5	159.	271.	3330.	5674.	-3805	-6485	1211.	2063.	-1593.	-2715.	0.	0.	439.	748.	-577.	-984.	0.	0.
	-6758.	8497.	406.	-323.	94.	-118.	-887.	1115.	2023.	-2543.	1561.	-1963.	-2449.	3079.	11165.	-14038	4309.	-5418.
15.0	188.	289.	3948.	6058.	-4511	-6922	1436.	2203.	-1889.	-2898.	0.	0.	520.	798.	-684.	-1050.	0.	0.
	-6479.	8224.	393.	-309.	90.	-114.	-851.	1080.	1939.	-2461.	1497.	-1900.	-2348.	2980.	10705.	-13586	4132.	-5244.
16.5	217.	308.	4544.	6462.	-5192	-7384	1652.	2350.	-2174.	-3092.	0.	0.	599.	851.	-788.	-1120.	0.	0.
	-6183.	7933.	379.	-295.	86.	-110.	-812.	1041.	1851.	-2374.	1428.	-1833.	-2240.	2874.	10215.	-13106	3943.	-5059.
18.0	245.	329.	5124.	6882.	-5856	-7865	1863.	2503.	-2452.	-3293.	0.	0.	675.	907.	-888.	-1193.	0.	0.
	-5871.	7628.	364.	-280.	82.	-106.	-771.	1001.	1757.	-2283.	1357.	-1762.	-2127.	2764.	9708.	-12603	3744.	-4864.
19.5	272.	349.	5692.	7315.	-6505	-8359	2070.	2660.	-2723.	-3500.	0.	0.	750.	964.	-987.	-1268.	0.	0.
	-5548.	7312.	349.	-265.	77.	-102.	-728.	960.	1661.	-2189.	1282.	-1689.	-2010.	2649.	9166.	-12081	3538.	-4663.
21.0	298.	370.	6250.	7757.	-7143	-8865	2273.	2821.	-2991.	-3712.	0.	0.	823.	1022.	-1084.	-1345.	0.	0.
	-5216.	6988.	334.	-249.	73.	-97.	-685.	917.	1561.	-2092.	1205.	-1615.	-1890.	2532.	8618.	-11545	3326.	-4456.
22.5	325.	392.	6801.	8207.	-7772	-9379	2473.	2984.	-3254.	-3927.	0.	0.	896.	1081.	-1179.	-1423.	0.	0.
	-4878.	6658.	318.	-233.	68.	-93.	-640.	874.	1460.	-1993.	1127.	-1538.	-1767.	2412.	8059.	-11000	3111.	-4246.
24.0	351.	414.	7345.	8663.	-8394	-9901	2671.	3150.	-3514.	-4145.	0.	0.	968.	1141.	-1273.	-1502.	0.	0.
	-4537.	6326.	302.	-217.	63.	-88.	-596.	830.	1358.	-1893.	1048.	-1462.	-1644.	2292.	7495.	-10451	2893.	-4034.
25.5	376.	436.	7884.	9125.	-9010	-10428	2867.	3318.	-3772.	-4366.	0.	0.	1039.	1202.	-1367.	-1582.	0.	0.
	-4195.	5994.	286.	-200.	58.	-83.	-551.	787.	1256.	-1794.	969.	-1385.	-1520.	2172.	6931.	-9903	2675.	-3822.
27.0	402.	458.	8419.	9591.	-9621	-10960	3061.	3488.	-4028.	-4589.	0.	0.	1109.	1264.	-1459.	-1663.	0.	0.
	-3856.	5665.	270.	-184.	54.	-79.	-506.	744.	1154.	-1695.	891.	-1309.	-1397.	2052.	6370.	-9358	2459.	-3612.

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 7-AUG-85:4

MAX VEH MPH	INNER SPROK	OUTER SPROK	INNER MOTOR	OUTER MOTOR	INNER A	OUTER A	INNER B	OUTER B	INNER C	OUTER C	INNER D	OUTER D	INNER E	OUTER E	INNER F	OUTER F	INNER G	OUTER G
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
28.5	427.	480.	8950.	10060.	-10229	-11497	3254.	3658.	-4282.	-4813.	0.	0.	1179.	1325.	-1552.	-1744.	0.	0.
	-3520.	5340.	255.	-168.	49.	-74.	-462.	701.	1054.	-1598.	813.	-1234.	-1276.	1935.	5816.	-8822	2245.	-3405.
30.0	452.	503.	9478.	10533.	-10831	-12037	3446.	3830.	-4535.	-5040.	0.	0.	1249.	1388.	-1643.	-1826.	0.	0.
	-3192.	5023.	240.	-152.	44.	-70.	-419.	659.	955.	-1503.	737.	-1160.	-1157.	1820.	5274.	-8298	2035.	-3203.
31.5	478.	525.	10003.	11008.	-11432	-12580	3638.	4003.	-4786.	-5267.	0.	0.	1318.	1450.	-1734.	-1908.	0.	0.
	-2872.	4715.	225.	-137.	40.	-66.	-377.	619.	860.	-1411.	664.	-1089.	-1041.	1708.	4745.	-7789	1831.	-3006.
33.0	502.	548.	10526.	11485.	-12029	-13125	3828.	4176.	-5036.	-5495.	0.	0.	1387.	1513.	-1825.	-1991.	0.	0.
	-2562.	4417.	211.	-122.	36.	-62.	-336.	580.	767.	-1322.	592.	-1021.	-928.	1600.	4233.	-7298	1534.	-2817.
34.5	527.	571.	11047.	11965.	-12625	-13673	4017.	4351.	-5286.	-5725.	0.	0.	1456.	1576.	-1915.	-2074.	0.	0.
	-2264.	4132.	197.	-108.	32.	-58.	-297.	542.	678.	-1237.	523.	-955.	-820.	1497.	3740.	-6826	1444.	-2635.
36.0	552.	594.	11567.	12446.	-13219	-14223	4206.	4526.	-5534.	-5955.	0.	0.	1524.	1640.	-2005.	-2158.	0.	0.
	-1978.	3860.	184.	-94.	28.	-54.	-260.	507.	592.	-1155.	457.	-892.	-717.	1399.	3269.	-6377	1262.	-2461.
37.5	577.	617.	12085.	12928.	-13810	-14775	4394.	4701.	-5782.	-6186.	0.	0.	1592.	1703.	-2095.	-2241.	0.	0.
	-1706.	3602.	172.	-81.	24.	-50.	-224.	473.	511.	-1078.	394.	-832.	-618.	1305.	2819.	-5951	1088.	-2297.
39.0	602.	640.	12601.	13412.	-14401	-15328	4582.	4877.	-6029.	-6417.	0.	0.	1660.	1767.	-2184.	-2325.	0.	0.
	-1449.	3360.	160.	-69.	20.	-47.	-190.	441.	434.	-1006.	335.	-776.	-525.	1217.	2394.	-5550	924.	-2142.
40.5	627.	663.	13127.	13887.	-15002	-15871	4773.	5050.	-6281.	-6645.	0.	0.	1729.	1830.	-2276.	-2407.	0.	0.
	-1123.	3049.	146.	-54.	16.	-42.	-147.	400.	336.	-912.	259.	-704.	-407.	1105.	1855.	-5036	716.	-1944.
42.0	652.	685.	13657.	14358.	-15607	-16408	4966.	5221.	-6534.	-6870.	0.	0.	1799.	1892.	-2368.	-2489.	0.	0.
	-768.	2710.	129.	-37.	11.	-38.	-101.	356.	230.	-811.	177.	-626.	-278.	982.	1269.	-4476	490.	-1728.
43.5	677.	708.	14186.	14829.	-16212	-16947	5159.	5392.	-6788.	-7095.	0.	0.	1869.	1954.	-2459.	-2571.	0.	0.
	-427.	2386.	114.	-20.	6.	-33.	-56.	313.	128.	-714.	99.	-551.	-155.	864.	706.	-3941	273.	-1521.
45.0	702.	730.	14716.	15300.	-16818	-17485	5351.	5564.	-7041.	-7320.	0.	0.	1939.	2016.	-2551.	-2652.	0.	0.
	-102.	2077.	99.	-5.	1.	-29.	-13.	273.	31.	-622.	24.	-480.	-37.	753.	169.	-3432	65.	-1325.

GEAR LOADS AT MAXIMUM TURN CONDITION   BY: RICK LEWIS;   REVISION: 16-JUL-85
RUN DATE: 20-AUG-85:112

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 40.0	TREAD WIDTH, in. = 109.8	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 183.1	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. =1000.0	TRACK PITCH, in. = 7.63	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 120.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 68.3	ROLLING RESISTANCE,lb per ton= 100.0	

Efficiency data for Westinghouse induction motor
by Craig Joseph 10-MAY-85

ALTERNATIVE I
TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
[illegible]	-71.	71.	1759.	1758.	-457.	457.	-126.	125.	329.	-329.	-71.	71.
	-25777.	25777.	1306.	-1305.	-4349.	4349.	-14616.	14616.	1395.	-1395.	-22829.	22826.
	-49.	86.	2134.	1201.	-554.	312.	-152.	86.	399.	-224.	-49.	86.
	-25450.	25450.	1289.	-1289.	-4294.	4294.	-14431.	14431.	1377.	-1377.	-22540.	22538.
3.0	10.	66.	1627.	240.	-422.	-62.	-116.	-17.	304.	45.	10.	66.
	-19796.	24248.	1228.	-1002.	-4091.	3340.	-13749.	11225.	1312.	-1071.	-17024.	21982.
4.5	17.	96.	2383.	417.	-619.	-108.	-170.	-30.	446.	78.	17.	96.
	-19710.	24164.	1224.	-998.	-4077.	3325.	-13701.	11176.	1308.	-1067.	-16947.	21908.
6.0	25.	126.	3118.	615.	-810.	-160.	-223.	-44.	583.	115.	25.	126.
	-19634.	24091.	1220.	-994.	-4064.	3313.	-13660.	11133.	1304.	-1063.	-16880.	21844.
7.5	39.	150.	3705.	962.	-962.	-250.	-264.	-69.	692.	180.	39.	150.
	-19405.	23865.	1209.	-982.	-4026.	3274.	-13532.	11003.	1292.	-1050.	-16676.	21644.
9.0	57.	169.	4184.	1416.	-1086.	-368.	-299.	-101.	782.	265.	57.	169.
	-19057.	23523.	1191.	-965.	-3969.	3215.	-13338.	10806.	1273.	-1031.	-16367.	21341.

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 20-AUG-85;112

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
10.5	77.	188.	4635.	1898.	-1204.	-493.	-331.	-135.	866.	355.	77.	188.
	-18672.	23143.	1172.	-945.	-3905.	3150.	-13123.	10587.	1253.	-1011.	-16026.	21006.
12.0	97.	205.	5072.	2395.	-1317.	-622.	-362.	-171.	948.	448.	97.	205.
	-18254.	22732.	1151.	-924.	-3835.	3080.	-12889.	10350.	1230.	-988.	-15655.	20642.
13.5	117.	223.	5515.	2885.	-1432.	-749.	-394.	-206.	1031.	539.	117.	223.
	-17839.	22324.	1131.	-903.	-3766.	3010.	-12658.	10115.	1208.	-966.	-15286.	20282.
15.0	140.	237.	5867.	3467.	-1524.	-900.	-419.	-247.	1097.	648.	140.	237.
	-17151.	21645.	1096.	-868.	-3652.	2894.	-12273.	9725.	1171.	-928.	-14676.	19682.
16.5	164.	252.	6224.	4042.	-1616.	-1050.	-444.	-289.	1163.	756.	164.	252.
	-16372.	20875.	1057.	-829.	-3522.	2762.	-11836.	9283.	1130.	-886.	-13985.	19001.
	186.	267.	6600.	4600.	-1714.	-1195.	-471.	-328.	1234.	860.	186.	267.
	-15554.	20067.	1016.	-787.	-3386.	2624.	-11378.	8819.	1086.	-842.	-13260.	18287.
	208.	283.	6990.	5144.	-1815.	-1336.	-499.	-367.	1307.	961.	208.	283.
	-14705.	19229.	974.	-745.	-3244.	2481.	-10903.	8338.	1041.	-796.	-12507.	17546.
21.0	230.	299.	7390.	5676.	-1919.	-1474.	-527.	-405.	1381.	1061.	230.	299.
	-13834.	18369.	930.	-700.	-3099.	2334.	-10415.	7844.	994.	-749.	-11733.	16786.
22.5	251.	316.	7800.	6200.	-2026.	-1610.	-557.	-443.	1458.	1159.	251.	316.
	-12946.	17494.	886.	-655.	-2951.	2184.	-9919.	7341.	947.	-701.	-10946.	16013.
24.0	272.	333.	8217.	6717.	-2134.	-1744.	-586.	-479.	1536.	1256.	272.	333.
	-12051.	16612.	841.	-610.	-2803.	2033.	-9419.	6833.	899.	-652.	-10151.	15233.
25.5	292.	350.	8639.	7227.	-2244.	-1877.	-617.	-516.	1615.	1351.	292.	350.
	-11155.	15731.	797.	-565.	-2654.	1882.	-8919.	6325.	851.	-604.	-9356.	14454.
27.0	313.	367.	9067.	7733.	-2355.	-2008.	-647.	-552.	1695.	1446.	313.	367.
	-10264.	14856.	752.	-520.	-2506.	1732.	-8423.	5820.	804.	-556.	-8566.	13681.

GEAR LOADS AT MAXIMUM TURN CONDITION   RUN DATE:No. 20-AUG-85;112

MAX VEH MPH	INNER SPROK	OUTER SPROK	INNER MOTOR=A	OUTER MOTOR=A	INNER B	OUTER B	INNER C & D	OUTER C & D	INNER E	OUTER E	INNER F	OUTER F
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftlbs	TORQUE ftlbs
28.5	333.	384.	9498.	8235.	-2467.	-2139.	-678.	-588.	1775.	1539.	333.	384.
	-9386.	13994.	709.	-475.	-2361.	1584.	-7935.	5322.	757.	-508.	-7786.	12919.
30.0	353.	402.	9933.	8733.	-2580.	-2268.	-709.	-623.	1857.	1632.	353.	402.
	-9526.	13150.	666.	-432.	-2219.	1438.	-7456.	4834.	712.	-461.	-7022.	12174.
31.5	373.	420.	10371.	9229.	-2693.	-2397.	-740.	-659.	1939.	1725.	373.	420.
	-7688.	12330.	625.	-389.	-2080.	1297.	-6991.	4359.	667.	-416.	-6278.	11450.
33.0	393.	438.	10812.	9721.	-2808.	-2525.	-772.	-694.	2021.	1817.	393.	438.
	-6877.	11539.	584.	-348.	-1947.	1160.	-6542.	3900.	625.	-372.	-5558.	10751.
	413.	455.	11255.	10212.	-2923.	-2652.	-803.	-729.	2104.	1909.	413.	455.
	-6098.	10778.	546.	-309.	-1818.	1029.	-6111.	3457.	583.	-330.	-4865.	10081.
	433.	473.	11700.	10700.	-3038.	-2779.	-835.	-764.	2187.	2000.	433.	473.
	-5352.	10053.	509.	-271.	-1696.	903.	-5700.	3035.	544.	-290.	-4202.	9441.
[illegible]	453.	492.	12147.	11187.	-3154.	-2905.	-867.	-798.	2271.	2091.	453.	492.
	-4643.	9365.	474.	-235.	-1580.	783.	-5310.	2632.	507.	-251.	-3572.	8834.
39.0	472.	510.	12595.	11672.	-3271.	-3031.	-899.	-833.	2354.	2182.	472.	510.
	-3972.	8717.	442.	-201.	-1471.	670.	-4942.	2252.	472.	-215.	-2975.	8262.
40.5	492.	528.	13044.	12156.	-3388.	-3157.	-931.	-868.	2438.	2272.	492.	528.
	-3340.	8108.	411.	-169.	-1368.	563.	-4597.	1894.	439.	-181.	-2413.	7726.
42.0	511.	546.	13495.	12638.	-3505.	-3282.	-963.	-902.	2523.	2362.	511.	546.
	-2749.	7541.	382.	-139.	-1272.	464.	-4276.	1558.	408.	-149.	-1886.	7226.
43.5	531.	564.	13947.	13120.	-3622.	-3407.	-995.	-936.	2607.	2452.	531.	564.
	-2197.	7015.	355.	-111.	-1183.	371.	-3977.	1246.	380.	-119.	-1395.	6763.
45.0	550.	583.	14400.	13600.	-3740.	-3532.	-1028.	-971.	2692.	2542.	550.	583.
	-1686.	6529.	331.	-85.	-1102.	284.	-3702.	956.	353.	-91.	-940.	6336.

End

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GEAR LOADS AT MAXIMUM TURN CONDITION          BY: RICK LEWIS:  REVISION: 8-JUN-85
                                                               RUN DATE: 15-AUG-85;113
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      INPUT DATA:
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   GROSS VEHICLE WEIGHT, tons =  40.0   TREAD WIDTH, in. = 109.8               GRADE, % =  0.0
   MAXIMUM VELOCITY, mph =  45.0        TRACK LENGTH, in. = 183.1              COEFFICIENT OF FRICTION = 0.70
   ENGINE GROSS HP. =1000.0             TRACK PITCH, in. = 7.63                MAXIMUM ACCELERATION, gs =0.50
   LOSS ENGINE HP. = 120.0              NUMBER OF SPROCKET TEETH = 11          COEFICIENT OF DRAG = 1.00
   FRONTAL AREA, ft^2 =  68.3           ROLLING RESISTANCE,lb per ton= 100.0   PROPULSION MOTOR EFF,% =94.
   STEER MOTOR EFF,% =   92.            STEER SYS. GEAR RATIO =  99:1          PROP. SYS. GEAR RATIO =  21:1

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   Efficiency data for Westinghouse induction motor *     ALTERNATIVE II
        by Craig Joseph 10-MAY-85                   *     PROPULSION/STEER MOTOR SET-UP

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MAX VEH MPH	INNER SPROK RPM	OUTER SPROK RPM	PROP MOTOR RPM	OUTER B RPM	INNER B RPM	OUTER C RPM	INNER C RPM	OUTER D RPM	INNER D RPM	OUTER E RPM	INNER E RPM	OUTER F RPM	INNER F RPM	STEER MOTOR RPM	H RPM	J RPM	K RPM	L RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
0.0	-65.	65.	0.	-982.	982.	376.	-376.	258.	-258.	-129.	129.	0.	0.	6428.	-1964.	0.	1219.	-319.
	-25773	25772	0	1283	-1283	13405	-13405	6443	-6443	-2147	2147	-19329	19329	562	-460	-2403	2966	11352
1.5	-52.	90.	398.	-834.	1321.	413.	-413.	359.	-208.	-179.	104.	0.	0.	7055.	-2156.	0.	1338.	-350.
	-25462	25071	-19	1266	-1250	13142	-13142	6267	-6365	-2089	2121	-18803	19096	551	-451	-2356	2907	11129
3.0	-35.	110.	797.	-613.	1587.	421.	-421.	440.	-138.	-220.	69.	0.	0.	7201.	-2200.	0.	1366.	-357.
	-25168	24538	-31	1250	-1224	12927	-12927	6134	-6292	-2044	2097	-18404	18876	542	-443	-2317	2860	10947
4.5	-17.	130.	1195.	-392.	1853.	430.	-430.	522.	-68.	-261.	34.	0.	0.	7348.	-2245.	0.	1394.	-364.
	-24890	24102	-39	1236	-1203	12741	-12741	6025	-6222	-2008	2074	-18077	18667	534	-437	-2284	2819	10790
6.0	1.	150.	1593.	-163.	2110.	435.	-435.	601.	3.	-300.	-2.	0.	0.	7441.	-2274.	0.	1411.	-369.
	-20161	23717	179	1019	-1166	11411	-11411	5929	-5040	-1976	1680	-17788	15121	478	-391	-2046	2524	9664
7.5	20.	169.	1991.	83.	2351.	434.	-434.	676.	79.	-338.	-40.	0.	0.	7425.	-2269.	0.	1408.	-368.
	-19876	23348	175	1004	-1147	11241	-11241	5837	-4969	-1945	1656	-17511	14907	471	-385	-2015	2487	9519
9.0	39.	188.	2390.	328.	2593.	434.	-434.	751.	156.	-375.	-78.	0.	0.	7412.	-2265.	0.	1406.	-367.
	-19593	23004	172	990	-1131	11078	-11078	5751	-4898	-1917	1632	-17253	14694	464	-380	-1986	2451	9381

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 15-AUG-85:113

MAX VEH MPH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
10.5	63.	202.	2788.	648.	2759.	404.	-404.	806.	251.	-403.	-126.	0.	0.	6910.	-2111.	0.	1311.	-342.
	-19177	22525	168	969	-1107	10845	-10845	5631	-4794	-1877	1598	-16893	14383	455	-372	-1944	2399	9184
12.0	90.	212.	3186.	1023.	2871.	354.	-354.	847.	362.	-424.	-181.	0.	0.	6046.	-1847.	0.	1147.	-300.
	-18559	21850	165	938	-1074	10509	-10509	5462	-4639	-1820	1546	-16387	13919	441	-360	-1884	2325	8900
13.5	116.	224.	3585.	1370.	3012.	314.	-314.	896.	464.	-448.	-232.	0.	0.	5374.	-1642.	0.	1019.	-266.
	-17881	21144	164	904	-1039	10149	-10149	5286	-4470	-1762	1490	-15858	13410	425	-348	-1819	2245	8595
15.0	140.	237.	3983.	1695.	3173.	283.	-283.	950.	561.	-475.	-281.	0.	0.	4837.	-1478.	0.	917.	-240.
	-17148	20407	164	867	-1002	9767	-9767	5101	-4287	-1700	1429	-15305	12861	409	-335	-1751	2161	8271
16.5	164.	252.	4381.	2006.	3349.	257.	-257.	1008.	654.	-504.	-327.	0.	0.	4397.	-1344.	0.	834.	-218.
	-16369	1964[illegible]	165	829	-964	9366	-9366	4910	-4092	-1636	1364	-14732	12277	393	-321	-1679	2072	7931
18.0	186.	267.	4779.	2305.	3537.	236.	-236.	1068.	745.	-534.	-372.	0.	0.	4031.	-1232.	0.	764.	-200.
	-15551	18855	166	788	-924	8948	-8948	4713	-3887	-1571	1295	-14141	11663	375	-307	-1604	1979	7578
19.5	208.	283.	5178.	2596.	3733.	218.	-218.	1131.	833.	-566.	-416.	0.	0.	3721.	-1137.	0.	706.	-184.
	-14703	18048	168	746	-884	8517	-8517	4512	-3675	-1504	1225	-13536	11027	357	-292	-1527	1884	7213
21.0	230.	299.	5576.	2880.	3935.	202.	-202.	1196.	919.	-598.	-459.	0.	0.	3455.	-1056.	0.	655.	-171.
	-13831	17228	171	703	-843	8077	-8077	4307	-3457	-1435	1152	-12921	10373	338	-277	-1448	1787	6840
22.5	251.	316.	5974.	3158.	4144.	189.	-189.	1263.	1004.	-631.	-502.	0.	0.	3225.	-985.	0.	612.	-160.
	-12944	16399	174	659	-801	7631	-7631	4099	-3236	-1366	1078	-12299	9708	320	-262	-1368	1688	6462
24.0	272.	333.	6373.	3433.	4356.	177.	-177.	1330.	1087.	-665.	-544.	0.	0.	3023.	-924.	0.	573.	-150.
	-12049	15568	177	615	-760	7182	-7182	3892	-3012	-1297	1004	-11676	9036	301	-246	-1287	1589	6082
25.5	292.	350.	6771.	3703.	4572.	166.	-166.	1398.	1170.	-699.	-585.	0.	0.	2845.	-869.	0.	540.	-141.
	-11153	14741	181	570	-718	6734	-6734	3685	-2788	-1228	929	-11056	8364	282	-231	-1207	1490	5703
27.0	313.	367.	7169.	3971.	4792.	157.	-157.	1468.	1252.	-734.	-626.	0.	0.	2687.	-821.	0.	510.	-133.
	-10262	13923	184	526	-677	6290	-6290	3480	-2565	-1160	855	-10442	7697	263	-215	-1127	1391	5326

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 15-AUG-85;113

MAX VEH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
MPH	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
28.5	333.	384.	7568.	4236.	5014.	149.	-149.	1538.	1333.	-769.	-667.	0.	0.	2546.	-778.	0.	483.	-126.
	-9384	13119	188	483	-637	5852	-5852	3279	-2346	-1093	782	-9839	7038	245	-200	-1049	1294	4956
30.0	353.	402.	7966.	4498.	5237.	142.	-142.	1608.	1414.	-804.	-707.	0.	0.	2418.	-739.	0.	459.	-120.
	-8524	12334	192	440	-598	5424	-5424	3083	-2131	-1027	710	-9250	6393	227	-186	-972	1200	4594
31.5	373.	420.	8364.	4759.	5463.	135.	-135.	1679.	1494.	-839.	-747.	0.	0.	2303.	-704.	0.	437.	-114.
	-7686	11572	196	399	-559	5008	-5008	2893	-1921	-364	640	-8679	5765	210	-171	-898	1108	4241
33.0	393.	438.	8762.	5019.	5691.	129.	-129.	1750.	1574.	-875.	-787.	0.	0.	2199.	-672.	0.	417.	-109.
	-6876	10838	199	359	-522	4607	-4607	2709	-1719	-903	573	-8128	5157	193	-158	-825	1019	3901
34.5	413.	455.	9161.	5277.	5919.	123.	-123.	1822.	1653.	-911.	-826.	0.	0.	2103.	-643.	0.	399.	-104.
	-6096	10133	203	320	-487	4221	-4221	2533	-1524	-844	508	-7600	4572	177	-144	-756	933	3574
36.0	433.	473.	9559.	5534.	6149.	118.	-118.	1894.	1732.	-947.	-866.	0.	0.	2015.	-616.	0.	382.	-100.
	-5351	9462	207	284	-453	3852	-3852	2365	-1337	-788	445	-7096	4013	161	-132	-690	852	3262
37.5	453.	492.	9957.	5789.	6381.	113.	-113.	1966.	1811.	-983.	-905.	0.	0.	1935.	-591.	0.	367.	-96.
	-4641	8826	211	249	-421	3502	-3502	2206	-1160	-735	386	-6619	3481	146	-120	-627	774	2966
39.0	472.	510.	10356.	6044.	6613.	109.	-109.	2039.	1889.	-1019.	-945.	0.	0.	1860.	-568.	0.	353.	-92.
	-3970	8227	214	215	-391	3172	-3172	2056	-992	-685	330	-6170	2978	133	-108	-568	701	2686
40.5	492.	528.	10754.	6298.	6845.	105.	-105.	2112.	1968.	-1056.	-984.	0.	0.	1791.	-547.	0.	340.	-89.
	-3339	7665	218	184	-363	2862	-2862	1916	-834	-638	278	-5748	2504	120	-98	-513	633	2423
42.0	511.	546.	11152.	6551.	7079.	101.	-101.	2185.	2046.	-1092.	-1023.	0.	0.	1727.	-528.	0.	328.	-86.
	-2748	7141	221	155	-336	2572	-2572	1785	-687	-595	229	-5356	2061	107	-88	-461	569	2178
43.5	531.	564.	11550.	6804.	7313.	98.	-98.	2258.	2124.	-1129.	-1062.	0.	0.	1668.	-510.	0.	316.	-83.
	-2196	6656	224	128	-312	2302	-2302	1664	-549	-554	183	-4992	1647	96	-79	-412	509	1949
45.0	550.	583.	11949.	7056.	7548.	94.	-94.	2331.	2201.	-1165.	-1101.	0.	0.	1612.	-493.	0.	306.	-80.
	-1685	6209	228	103	-289	2053	-2053	1552	-421	-517	140	-4656	1264	86	-70	-368	454	1738

End

GEAR LOADS AT MAXIMUM TURN CONDITION   BY: RICK LEWIS: REVISION: 16-JUL-85
RUN DATE: 15-AUG-85:111

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 40.0	TREAD WIDTH, in. = 109.8	GRADE, % = 0.0
MAXIMUM VELOCITY, mph = 45.0	TRACK LENGTH, in. = 183.1	COEFFICIENT OF FRICTION = 0.70
ENGINE GROSS HP. =1000.0	TRACK PITCH, in. = 7.63	MAXIMUM ACCELERATION, gs =0.50
LOSS ENGINE HP. = 120.0	NUMBER OF SPROCKET TEETH = 11	COEFICIENT OF DRAG = 1.00
FRONTAL AREA, ft^2 = 68.3	ROLLING RESISTANCE,lb per ton= 100.0	

Efficiency data for Homopolar motor   *   CONFIGURATION I
by Gene Siedler 20-MAY-85   *   TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
0.0	-67.	67.	-1410.	1411.	1611	-1612	-513.	513.	675.	-675.	0.	0.	-186.	186.	244.	-245.	0.	0.
	-25773	25773	1230.	-1230.	359.	-359.	-3383.	3383.	7714.	-7714.	5955.	-5955.	-9338.	9338.	42582.	-42582	16435.	-16435
1.5	-45.	83.	-949.	1740.	1084	-1988	-345.	633.	454.	-833.	0.	0.	-125.	229.	165.	-302.	0.	0.
	-25430	25430	1214.	-1214.	354.	-354.	-3338.	3338.	7612.	-7612.	5876.	-5876.	-9214.	9214.	42016.	-42015	16217.	-16216
3.0	10.	65.	216.	1367.	-246	-1562	78.	497.	-103.	-654.	0.	0.	28.	180.	-37.	-237.	0.	0.
	-19762	24213	1156.	-943.	275.	-337.	-2594.	3179.	5915.	-7247.	4566.	-5594.	-7160.	8773.	32651.	-40005	12602.	-15440
4.5	18.	96.	370.	2004.	-422	-2289	135.	729.	-177.	-959.	0.	0.	49.	264.	-64.	-347.	0.	0.
	-19675	24128	1152.	-939.	274.	-336.	-2583.	3167.	5889.	-7222.	4546.	-5575.	-7129.	8742.	32507.	-39864	12546.	-15386
6.0	26.	125.	540.	2625.	-617	-2999	196.	955.	-258.	-1256.	0.	0.	71.	346.	-94.	-455.	0.	0.
	-19602	24059	1149.	-936.	273.	-335.	-2573.	3158.	5867.	-7201.	4529.	-5559.	-7102.	8717.	32387.	-39750	12500.	-15342
7.5	42.	147.	876.	3080.	-1001	-3520	319.	1120.	-419.	-1474.	0.	0.	115.	406.	-152.	-534.	0.	0.
	-19301	23761	1134.	-921.	269.	-331.	-2534.	3119.	5777.	-7112.	4459.	-5490.	-6993.	8609.	31889.	-39258	12308.	-15152
9.0	61.	165.	1284.	3464.	-1466	-3958	467.	1260.	-614.	-1657.	0.	0.	169.	456.	-223.	-600.	0.	0.
	-18891	23357	1115.	-902.	263.	-325.	-2480.	3066.	5654.	-6991.	4365.	-5397.	-6845.	8463.	31212.	-38589	12047.	-14894

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 15-AUG-85;111

MAX VEH MPH	INNER SPROK RPM	OUTER SPROK RPM	INNER MOTOR RPM	OUTER MOTOR RPM	INNER A RPM	OUTER A RPM	INNER B RPM	OUTER B RPM	INNER C RPM	OUTER C RPM	INNER D RPM	OUTER D RPM	INNER E RPM	OUTER E RPM	INNER F RPM	OUTER F RPM	INNER G RPM	OUTER G RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
10.5	82.	183.	1712.	3826.	-1956	-4373	623.	1391.	-819.	-1831.	0.	0.	226.	504.	-297.	-663.	0.	0.
	-18427	22898	1093.	-880.	257.	-319.	-2419.	3006.	5516.	-6854.	4258.	-5291.	-6677.	8297.	30446.	-37832	11751.	-14602
12.0	102.	200.	2137.	4193.	-2442	-4791	777.	1525.	-1023.	-2006.	0.	0.	282.	552.	-371.	-727.	0.	0.
	-17955	22433	1071.	-857.	250.	-312.	-2357.	2945.	5374.	-6714.	4149.	-5183.	-6506.	8128.	29666.	-37063	11450.	-14305
13.5	123.	217.	2566.	4555.	-2932	-5205	933.	1656.	-1228.	-2179.	0.	0.	338.	600.	-445.	-790.	0.	0.
	-17452	21937	1047.	-833.	243.	-305.	-2291.	2880.	5224.	-6566.	4032.	-5069.	-6323.	7948.	28835.	-36245	11129.	-13989
15.0	143.	234.	3005.	4908.	-3433	-5608	1093.	1785.	-1438.	-2348.	0.	0.	396.	647.	-521.	-851.	0.	0.
	-16890	21383	1021.	-806.	235.	-298.	-2217.	2807.	5055.	-6400.	3902.	-4941.	-6120.	7748.	27905.	-35329	10771.	-13635
16.5	164.	251.	3442.	5262.	-3933	-6013	1252.	1913.	-1647.	-2517.	0.	0.	453.	693.	-597.	-912.	0.	0.
	-16297	20800	993.	-778.	227.	-290.	-2139.	2731.	4878.	-6226.	3765.	-4806.	-5905.	7536.	26926.	-34365	10393.	-13263
18.0	186.	267.	3900.	5595.	-4456	-6394	1418.	2035.	-1866.	-2677.	0.	0.	514.	737.	-676.	-970.	0.	0.
	-15551	20064	958.	-742.	217.	-279.	-2042.	2634.	4655.	-6005.	3593.	-4636.	-5635.	7270.	25695.	-33150	9917.	-12794
19.5	208.	283.	4360.	5926.	-4983	-6772	1586.	2155.	-2086.	-2835.	0.	0.	575.	781.	-756.	-1027.	0.	0.
	-14703	19226	918.	-702.	205.	-268.	-1930.	2524.	4401.	-5755.	3397.	-4442.	-5327.	6966.	24292.	-31766	9376.	-12260
21.0	230.	299.	4812.	6265.	-5499	-7160	1750.	2278.	-2302.	-2998.	0.	0.	634.	825.	-834.	-1086.	0.	0.
	-13831	18366	877.	-660.	193.	-256.	-1816.	2411.	4140.	-5497.	3196.	-4244.	-5011.	6655.	22852.	-30345	8820.	-11712
22.5	251.	316.	5256.	6612.	-6006	-7557	1911.	2405.	-2515.	-3164.	0.	0.	692.	871.	-911.	-1146.	0.	0.
	-12944	17492	835.	-618.	180.	-244.	-1699.	2296.	3874.	-5236.	2991.	-4041.	-4690.	6338.	21386.	-28900	8254.	-11154
24.0	272.	333.	5694.	6966.	-6507	-7960	2071.	2533.	-2724.	-3333.	0.	0.	750.	918.	-987.	-1208.	0.	0.
	-12049	16610	793.	-575.	168.	-231.	-1582.	2181.	3606.	-4972.	2784.	-3838.	-4366.	6018.	19907.	-27443	7683.	-10592
25.5	292.	350.	6127.	7324.	-7002	-8370	2228.	2663.	-2932.	-3504.	0.	0.	807.	965.	-1062.	-1270.	0.	0.
	-11153	15729	751.	-532.	155.	-219.	-1464.	2065.	3338.	-4708.	2577.	-3634.	-4041.	5699.	18427.	-25987	7112.	-10030
27.0	313.	367.	6556.	7686.	-7492	-8784	2384.	2795.	-3137.	-3678.	0.	0.	864.	1013.	-1137.	-1332.	0.	0.
	-10262	14854	709.	-490.	143.	-207.	-1347.	1950.	3072.	-4446.	2371.	-3432.	-3718.	5382.	16956.	-24541	6544.	-9472

GEAR LOADS AT MAXIMUM TURN CONDITION RUN DATE:No. 15-AUG-85:111

MAX VEH MPH	INNER SPROK	OUTER SPROK	INNER MOTOR	OUTER MOTOR	INNER A	OUTER A	INNER B	OUTER B	INNER C	OUTER C	INNER D	OUTER D	INNER E	OUTER E	INNER F	OUTER F	INNER G	OUTER G
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
28.5	333.	384.	6981.	8052.	-7978	-9202	2539.	2928.	-3340.	-3853.	0.	0.	920.	1061.	-1210.	-1396.	0.	0.
	-9384	13992	668.	-448.	131.	-195.	-1232.	1837.	2809.	-4188.	2168.	-3233.	-3400.	5070.	15505.	-23117	5985.	-8922
30.0	353.	402.	7404.	8421.	-8461	-9623	2692.	3062.	-3542.	-4029.	0.	0.	975.	1109.	-1283.	-1460.	0.	0.
	-8524	13148	628.	-407.	119.	-183.	-1119.	1726.	2551.	-3936.	1970.	-3038.	-3089.	4764.	14084.	-21724	5436.	-8384
31.5	373.	420.	7823.	8792.	-8941	-10048	2845.	3197.	-3743.	-4207.	0.	0.	1031.	1158.	-1356.	-1524.	0.	0.
	-7686	12329	589.	-367.	107.	-172.	-1009.	1619.	2301.	-3690.	1776.	-2849.	-2785.	4467.	12700.	-20369	4902.	-7862
33.0	393.	438.	8241.	9166.	-9418	-10475	2997.	3333.	-3943.	-4386.	0.	0.	1086.	1208.	-1429.	-1589.	0.	0.
	-6876	11537	551.	-328.	96.	-161.	-903.	1515.	2058.	-3453.	1589.	-2666.	-2491.	4180.	11361.	-19061	4385.	-7357
34.5	413.	455.	8657.	9541.	-9893	-10904	3148.	3470.	-4142.	-4565.	0.	0.	1141.	1257.	-1501.	-1654.	0.	0.
	-6096	10777	514.	-291.	85.	-150.	-800.	1415.	1825.	-3226.	1409.	-2490.	-2209.	3905.	10073.	-17806	3888.	-6872
36.0	433.	473.	9071.	9919.	-10366	-11335	3299.	3607.	-4340.	-4746.	0.	0.	1195.	1307.	-1573.	-1719.	0.	0.
	-5351	10052	480.	-255.	75.	-140.	-702.	1320.	1602.	-3009.	1236.	-2323.	-1939.	3642.	8841.	-16608	3412.	-6410
37.5	453.	492.	9483.	10297.	-10838	-11768	3449.	3744.	-4538.	-4927.	0.	0.	1249.	1357.	-1644.	-1785.	0.	0.
	-4641	9364	447.	-222.	65.	-130.	-609.	1229.	1389.	-2803.	1072.	-2164.	-1682.	3393.	7669.	-15471	2960.	-5971
39.0	472.	510.	9895.	10677.	-11308	-12202	3598.	3883.	-4734.	-5109.	0.	0.	1304.	1407.	-1715.	-1851.	0.	0.
	-3970	8715	416.	-190.	55.	-121.	-521.	1144.	1188.	-2609.	917.	-2014.	-1439.	3158.	6560.	-14400	2532.	-5557
40.5	492.	528.	10305.	11058.	-11776	-12638	3747.	4021.	-4931.	-5291.	0.	0.	1358.	1457.	-1786.	-1917.	0.	0.
	-3339	8107	387.	-159.	46.	-113.	-438.	1064.	999.	-2427.	772.	-1873.	-1210.	2938.	5517.	-13395	2129.	-5170
42.0	512.	546.	10716.	11439.	-12246	-13072	3897.	4160.	-5127.	-5473.	0.	0.	1412.	1507.	-1858.	-1983.	0.	0.
	-2708	7500	358.	-129.	38.	-104.	-356.	985.	811.	-2245.	626.	-1733.	-981.	2718.	4474.	-12391	1727.	-4782
43.5	531.	564.	11134.	11812.	-12724	-13499	4049.	4295.	-5327.	-5652.	0.	0.	1467.	1556.	-1930.	-2048.	0.	0.
	-1944	6761	323.	-93.	27.	-94.	-255.	888.	582.	-2024.	449.	-1562.	-704.	2450.	3212.	-11171	1240.	-4311
45.0	551.	582.	11552.	12185.	-13201	-13926	4201.	4431.	-5527.	-5830.	0.	0.	1522.	1605.	-2003.	-2112.	0.	0.
	-1212	6055	289.	-58.	17.	-84.	-159.	795.	363.	-1812.	280.	-1399.	-439.	2194.	2004.	-10004	773.	-3861

B.2.E Maximum Power Gear Loads And Speeds

These tables are identical to those of Appendix Section B.2.D except that they are for the full range of specified speed vs tractive effort. Refer to Section B.2.D if a detailed explanation of the data sheets is needed.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION — BY: RICK LEWIS: REVISION: 8-JUN-85

RUN DATE: 20-AUG-85;8

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5 — MAXIMUM VELOCITY, mph = 45.0 — ENGINE NET HP. = 440.0

TRACK PITCH, in. = 6.03 — NUMBER OF SPROCKET TEETH = 11

Efficiency data for Westinghouse induction motor by Craig Joseph 10-MAY-85

CONFIGURATION I

TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK	OUTER SPROK	INNER MOTOR=A	OUTER MOTOR=A	INNER B	OUTER B	INNER C & D	OUTER C & D	INNER E	OUTER E	INNER F	OUTER F
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftlbs	TORQUE ftlbs
	24.	24.	500.	500.	-153.	-153.	-42.	-42.	110.	110.	24.	24.
	20596.	20596.	1043.	1043.	-3475.	-3475.	-11678.	-11678.	1115.	1115.	2355.	2357.
3.0	48.	48.	999.	999.	-306.	-306.	-84.	-84.	221.	221.	48.	48.
	15646.	15646.	792.	792.	-2640.	-2640.	-8871.	-8871.	847.	847.	1789.	1791.
4.5	72.	72.	1499.	1499.	-460.	-460.	-126.	-126.	331.	331.	72.	72.
	11201.	11201.	567.	567.	-1890.	-1890.	-6351.	-6351.	606.	506.	1281.	1282.
6.0	96.	96.	1999.	1999.	-613.	-613.	-168.	-168.	441.	441.	96.	96.
	8746.	8746.	443.	443.	-1476.	-1476.	-4959.	-4959.	473.	473.	1000.	1001.
7.5	119.	119.	2499.	2499.	-766.	-766.	-211.	-211.	552.	552.	119.	119.
	7151.	7151.	362.	362.	-1206.	-1206.	-4055.	-4055.	387.	387.	818.	818.
9.0	143.	143.	2998.	2998.	-919.	-919.	-253.	-253.	662.	662.	143.	143.
	6088.	6088.	308.	308.	-1027.	-1027.	-3452.	-3452.	330.	330.	696.	697.

GEAR LOADS AT MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 20-AUG-85:8

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs.	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
10.5	167.	167.	3498.	3498.	-1073.	-1073.	-295.	-295.	772.	772.	167.	167.
	5314.	5314.	269.	269.	-896.	-896.	-3013.	-3013.	288.	288.	608.	608.
12.0	191.	191.	3998.	3998.	-1226.	-1226.	-337.	-337.	882.	882.	191.	191.
	4675.	4675.	237.	237.	-789.	-789.	-2651.	-2651.	253.	253.	535.	535.
13.5	215.	215.	4498.	4498.	-1379.	-1379.	-379.	-379.	993.	993.	215.	215.
	4179.	4179.	212.	212.	-705.	-705.	-2369.	-2369.	226.	226.	478.	478.
15.0	239.	239.	4997.	4997.	-1532.	-1532.	-421.	-421.	1103.	1103.	239.	239.
	3781.	3781.	192.	191.	-638.	-638.	-2144.	-2144.	205.	205.	432.	433.
16.5	263.	263.	5497.	5497.	-1686.	-1686.	-463.	-463.	1213.	1213.	263.	263.
	3456.	3456.	175.	175.	-583.	-583.	-1960.	-1960.	187.	187.	395.	396.
	287.	287.	5997.	5997.	-1839.	-1839.	-505.	-505.	1324.	1324.	287.	287.
	3186.	3186.	161.	161.	-537.	-537.	-1806.	-1806.	172.	172.	364.	365.
	310.	310.	6497.	6497.	-1992.	-1992.	-548.	-548.	1434.	1434.	310.	310.
	2940.	2940.	149.	149.	-496.	-496.	-1667.	-1667.	159.	159.	336.	336.
21.0	334.	334.	6996.	6996.	-2145.	-2145.	-590.	-590.	1544.	1544.	334.	334.
	2730.	2730.	138.	138.	-461.	-461.	-1548.	-1548.	148.	148.	312.	312.
22.5	358.	358.	7496.	7496.	-2299.	-2299.	-632.	-632.	1655.	1655.	358.	358.
	2547.	2547.	129.	129.	-430.	-430.	-1444.	-1444.	138.	138.	291.	292.
24.0	382.	382.	7996.	7996.	-2452.	-2452.	-674.	-674.	1765.	1765.	382.	382.
	2387.	2387.	121.	121.	-403.	-403.	-1354.	-1354.	129.	129.	273.	273.
25.5	406.	406.	8496.	8496.	-2605.	-2605.	-716.	-716.	1875.	1875.	406.	406.
	2247.	2247.	114.	114.	-379.	-379.	-1274.	-1274.	122.	122.	257.	257.
27.0	430.	430.	8995.	8995.	-2758.	-2758.	-758.	-758.	1986.	1986.	430.	430.
	[illegible]	2121.	107.	107.	-358.	-358.	-1203.	-1203.	115.	115.	243.	243.

GEAR LOADS AT MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 20-AUG-85;8

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
28.5	454.	454.	9495.	9495.	-2912.	-2912.	-800.	-800.	2096.	2096.	454.	454.
	2009.	2009.	102.	102.	-339.	-339.	-1139.	-1139.	109.	109.	230.	230.
30.0	478.	478.	9995.	9995.	-3065.	-3065.	-842.	-842.	2206.	2206.	478.	478.
	1908.	1908.	97.	97.	-322.	-322.	-1082.	-1082.	103.	103.	218.	218.
31.5	501.	501.	10495.	10495.	-3218.	-3218.	-884.	-884.	2316.	2316.	501.	501.
	1817.	1817.	92.	92.	-307.	-307.	-1030.	-1030.	98.	98.	208.	208.
33.0	525.	525.	10994.	10994.	-3371.	-3371.	-927.	-927.	2427.	2427.	525.	525.
	1734.	1734.	88.	88.	-293.	-293.	-983.	-983.	94.	94.	198.	198.
34.5	549.	549.	11494.	11494.	-3525.	-3525.	-969.	-969.	2537.	2537.	549.	549.
	1659.	1659.	84.	84.	-280.	-280.	-940.	-940.	90.	90.	190.	190.
	573.	573.	11994.	11994.	-3678.	-3678.	-1011.	-1011.	2647.	2647.	573.	573.
	1589.	1589.	80.	80.	-268.	-268.	-901.	-901.	86.	86.	182.	182.
	597.	597.	12494.	12494.	-3831.	-3831.	-1053.	-1053.	2758.	2758.	597.	597.
	1522.	1522.	77.	77.	-257.	-257.	-863.	-863.	82.	82.	174.	174.
39.0	621.	621.	12993.	12993.	-3984.	-3984.	-1095.	-1095.	2868.	2868.	621.	621.
	1461.	1461.	74.	74.	-246.	-246.	-828.	-828.	79.	79.	167.	167.
40.5	645.	645.	13493.	13493.	-4138.	-4138.	-1137.	-1137.	2978.	2978.	645.	645.
	1403.	1403.	71.	71.	-237.	-237.	-796.	-796.	76.	76.	160.	161.
42.0	669.	669.	13993.	13993.	-4291.	-4291.	-1179.	-1179.	3089.	3089.	669.	669.
	1350.	1350.	68.	68.	-228.	-228.	-766.	-766.	73.	73.	154.	155.
43.5	693.	693.	14493.	14493.	-4444.	-4444.	-1221.	-1221.	3199.	3199.	693.	693.
	1301.	1301.	66.	66.	-219.	-219.	-738.	-738.	70.	70.	149.	149.
45.0	716.	7.6.	14992.	14992.	-4597.	-4597.	-1264.	-1264.	3309.	3309.	716.	716.
	1255.	1255.	64.	64.	-212.	-212.	-712.	-712.	68.	68.	144.	144.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION   BY: RICK LEWIS; REVISION: 8-JUN-85
RUN DATE: 7-AUG-85;9

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5   MAXIMUM VELOCITY, mph = 45.0   ENGINE NET HP. = 440.0
TRACK PITCH, in. = 6.03   NUMBER OF SPROCKET TEETH = 11

Efficiency data for Westinghouse induction motor
by Craig Joseph 10-MAY-85

CONFIGURATION II
PROPULSION/STEER MOTOR SET-UP

MAX VEH MPH		INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
		RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs
1.5	RPM	24.	24.	504.	308.	308.	0.	0.	96.	96.	-48.	-48.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	20596.	20596.	1006.	-12.	-12.	4172.	4172.	5226.	5226.	-26.	-26.	15215.	15215.	-2565.	4196.	32872.	13522.	-3533.
3.0	RPM	48.	48.	1007.	616.	616.	0.	0.	191.	191.	-96.	-96.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	15313.	15313.	748.	-9.	-9.	3102.	3102.	3886.	3886.	-19.	-19.	11312.	11312.	-1907.	3120.	24440.	10053.	-2627.
4.5	RPM	72.	72.	1511.	923.	923.	0.	0.	287.	287.	-143.	-143.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	10963.	10963.	535.	-6.	-6.	2220.	2220.	2782.	2782.	-14.	-14.	8099.	8099.	-1365.	2234.	17497.	7197.	-1880.
6.0	RPM	96.	96.	2015.	1231.	1231.	0.	0.	382.	382.	-191.	-191.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	8560.	8560.	418.	-5.	-5.	1734.	1734.	2172.	2172.	-11.	-11.	6324.	6324.	-1066.	1744.	13662.	5620.	-1468.
7.5	RPM	119.	119.	2518.	1539.	1539.	0.	0.	478.	478.	-239.	-239.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	6999.	6999.	342.	-4.	-4.	1418.	1418.	1776.	1776.	-9.	-9.	5170.	5170.	-871.	1426.	11171.	4595.	-1200.
9.0	RPM	143.	143.	3022.	1847.	1847.	0.	0.	573.	573.	-287.	-287.	0.	0.	0.	0.	0.	0.	0.
	TORQUE	5959.	5959.	291.	-4.	-4.	1207.	1207.	1512.	1512.	-7.	-7.	4402.	4402.	-742.	1214.	9510.	3912.	-1022.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 7-AUG-85;9

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	PROP MOTOR RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	STEER MOTOR RPM / TORQUE ftxlbs	H RPM / TORQUE ftxlbs	J RPM / TORQUE ftxlbs	K RPM / TORQUE ftxlbs	L RPM / TORQUE ftxlbs
10.5	167.	167.	3525.	2154.	2154.	0.	0.	669.	669.	-334.	-334.	0.	0.	0.	0.	0.	0.	0.
	5201.	5201.	254.	-3.	-3.	1053.	1053.	1320.	1320.	-7.	-7.	3842.	3842.	-648.	1060.	8301.	3414.	-892.
12.0	191.	191.	4029.	2462.	2462.	0.	0.	764.	764.	-382.	-382.	0.	0.	0.	0.	0.	0.	0.
	4576.	4576.	224.	-3.	-3.	927.	927.	1161.	1161.	-6.	-6.	3380.	3380.	-570.	932.	7303.	3004.	-785.
13.5	215.	215.	4533.	2770.	2770.	0.	0.	860.	860.	-430.	-430.	0.	0.	0.	0.	0.	0.	0.
	4090.	4090.	200.	-2.	-2.	828.	828.	1038.	1038.	-5.	-5.	3021.	3021.	-509.	833.	6527.	2685.	-701.
15.0	239.	239.	5036.	3078.	3078.	0.	0.	955.	955.	-478.	-478.	0.	0.	0.	0.	0.	0.	0.
	3701.	3701.	181.	-2.	-2.	750.	750.	939.	939.	-5.	-5.	2734.	2734.	-461.	754.	5907.	2430.	-635.
16.5	263.	263.	5540.	3386.	3386.	0.	0.	1051.	1051.	-525.	-525.	0.	0.	0.	0.	0.	0.	0.
	3383.	3383.	165.	-2.	-2.	685.	685.	858.	858.	-4.	-4.	2499.	2499.	-421.	689.	5399.	2221.	-580.
18.0	287.	287.	6044.	3693.	3693.	0.	0.	1146.	1146.	-573.	-573.	0.	0.	0.	0.	0.	0.	0.
	3118.	3118.	152.	-2.	-2.	631.	631.	791.	791.	-4.	-4.	2303.	2303.	-388.	635.	4976.	2047.	-535.
19.5	310.	310.	6547.	4001.	4001.	0.	0.	1242.	1242.	-621.	-621.	0.	0.	0.	0.	0.	0.	0.
	2878.	2878.	141.	-2.	-2.	583.	583.	730.	730.	-4.	-4.	2126.	2126.	-358.	586.	4593.	1889.	-494.
21.0	334.	334.	7051.	4309.	4309.	0.	0.	1337.	1337.	-669.	-669.	0.	0.	0.	0.	0.	0.	0.
	2671.	267'.	130.	-2.	-2.	541.	541.	678.	678.	-3.	-3.	1974.	1974.	-333.	544.	4264.	1754.	-458.
22.5	358.	358.	7555.	4617.	4617.	0.	0.	1433.	1433.	-716.	-716.	0.	0.	0.	0.	0.	0.	0.
	2493.	2493.	122.	-1.	-1.	505.	505.	633.	633.	-3.	-3.	1842.	1842.	-310.	508.	3979.	1637.	-428.
24.0	382.	382.	8058.	4924.	4924.	0.	0.	1528.	1528.	-764.	-764.	0.	0.	0.	0.	0.	0.	0.
	2337.	2337.	114.	-1.	-1.	473.	473.	593.	593.	-3.	-3.	1726.	1726.	-291.	476.	3729.	1534.	-401.
25.5	406.	406.	8562.	5232.	5232.	0.	0.	1624.	1624.	-812.	-812.	0.	0.	0.	0.	0.	0.	0.
	2199.	2199.	107.	-1.	-1.	445.	445.	558.	558.	-3.	-3.	1624.	1624.	-274.	448.	3509.	1444.	-377.
27.0	430.	430.	9066.	5540.	5540.	0.	0.	1719.	1719.	-860.	-860.	0.	0.	0.	0.	0.	0.	0.
	2076.	2076.	101.	-1.	-1.	421.	421.	527.	527.	-3.	-3.	1534.	1534.	-259.	423.	3314.	1363.	-356.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION   RUN DATE:No. 7-AUG-85;9

MAX VEH MPH	INNER SPROK RPM	OUTER SPROK RPM	PROP MOTOR RPM	OUTER B RPM	INNER B RPM	OUTER C RPM	INNER C RPM	OUTER D RPM	INNER D RPM	OUTER E RPM	INNER E RPM	OUTER F RPM	INNER F RPM	STEER MOTOR RPM	H RPM	J RPM	K RPM	L RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
28.5	454.	454.	9569.	5848.	5848.	0.	0.	1815.	1815.	-907.	-907.	0.	0.	0.	0.	0.	0.	0.
	1967.	1967.	96.	-1.	-1.	398.	398.	499.	499.	-2.	-2.	1453.	1453.	-245.	401.	3139.	1291.	-337.
30.0	478.	478.	10073.	6156.	6156.	0.	0.	1910.	1910.	-955.	-955.	0.	0.	0.	0.	0.	0.	0.
	1868.	1868.	91.	-1.	-1.	378.	378.	474.	474.	-2.	-2.	1380.	1380.	-233.	381.	2981.	1226.	-320.
31.5	501.	501.	10576.	6463.	6463.	0.	0.	2006.	2006.	-1003.	-1003.	0.	0.	0.	0.	0.	0.	0.
	1779.	1779.	87.	-1.	-1.	360.	360.	451.	451.	-2.	-2.	1314.	1314.	-221.	362.	2839.	1168.	-305.
33.0	525.	525.	11080.	6771.	6771.	0.	0.	2101.	2101.	-1051.	-1051.	0.	0.	0.	0.	0.	0.	0.
	1697.	1697.	83.	-1.	-1.	344.	344.	431.	431.	-2.	-2.	1254.	1254.	-211.	346.	2709.	1114.	-291.
34.5	549.	549.	11584.	7079.	7079.	0.	0.	2197.	2197.	-1099.	-1099.	0.	0.	0.	0.	0.	0.	0.
	1623.	1623.	79.	-1.	-1.	329.	329.	412.	412.	-2.	-2.	1199.	1199.	-202.	331.	2591.	1066.	-278.
36.0	573.	573.	12087.	7387.	7387.	0.	0.	2293.	2293.	-1146.	-1146.	0.	0.	0.	0.	0.	0.	0.
	1555.	1555.	76.	-1.	-1.	315.	315.	395.	395.	-2.	-2.	1149.	1149.	-194.	317.	2482.	1021.	-267.
37.5	597.	597.	12591.	7695.	7695.	0.	0.	2388.	2388.	-1194.	-1194.	0.	0.	0.	0.	0.	0.	0.
	1490.	1490.	73.	-1.	-1.	302.	302.	378.	378.	-2.	-2.	1101.	1101.	-186.	304.	2378.	978.	-256.
39.0	621.	621.	13095.	8002.	8002.	0.	0.	2484.	2484.	-1242.	-1242.	0.	0.	0.	0.	0.	0.	0.
	1430.	1430.	70.	-1.	-1.	290.	290.	363.	363.	-2.	-2.	1056.	1056.	-178.	291.	2282.	938.	-245.
40.5	645.	645.	13598.	8310.	8310.	0.	0.	2579.	2579.	-1290.	-1290.	0.	0.	0.	0.	0.	0.	0.
	1374.	1374.	67.	-1.	-1.	278.	278.	349.	349.	-2.	-2.	1015.	1015.	-171.	280.	2192.	902.	-236.
42.0	669.	669.	14102.	8618.	8618.	0.	0.	2675.	2675.	-1337.	-1337.	0.	0.	0.	0.	0.	0.	0.
	1322.	1322.	65.	-1.	-1.	268.	268.	335.	335.	-2.	-2.	976.	976.	-165.	269.	2109.	868.	-227.
43.5	693.	693.	14606.	8926.	8926.	0.	0.	2770.	2770.	-1385.	-1385.	0.	0.	0.	0.	0.	0.	0.
	1273.	1273.	62.	-1.	-1.	258.	258.	323.	323.	-2.	-2.	941.	941.	-159.	259.	2032.	836.	-218.
45.0	716.	716.	15109.	9233.	9233.	0.	0.	2866.	2866.	-1433.	-1433.	0.	0.	0.	0.	0.	0.	0.
	1228.	1228.	60.	-1.	-1.	249.	249.	312.	312.	-2.	-2.	907.	907.	-153.	250.	1960.	806.	-211.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION   BY: RICK LEWIS; REVISION: 8-JUN-85
RUN DATE: 7-AUG-85;7

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 19.5   MAXIMUM VELOCITY, mph = 45.0   ENGINE NET HP. = 440.0
TRACK PITCH, in. = 6.03   NUMBER OF SPROCKET TEETH = 11

Efficiency data for Homopolar motor   *   CONFIGURATION I
by Gene Siedler 20-MAY-85   *   TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
1.5	24.	24.	500.	500.	-571	-571	182.	182.	-239.	-239.	0.	0.	66.	66.	-87.	-87.	0.	0.
	19131.	19130	-320.	-320.	280.	280.	2511.	2511.	-519.	-519.	-2789.	-2789.	6931.	6931.	-716.	-716.	-7697	-7697
3.0	48.	48.	1001.	1001.	-1143	-1143	364.	364.	-479.	-479.	0.	0.	132.	132.	-173.	-173.	0.	0.
	15265.	15264	-255.	-255.	223.	223.	2004.	2004.	-414.	-414.	-2225.	-2225.	5531.	5531.	-571.	-571.	-6142	-6142
4.5	72.	72.	1501.	1501.	-1715	-1715	546.	546.	-718.	-718.	0.	0.	198.	198.	-260.	-260.	0.	0.
	10793.	10792	-180.	-180.	158.	158.	1417.	1417.	-293.	-293.	-1573.	-1573.	3910.	3910.	-404.	-404.	-4342	-4342
6.0	96.	96.	2001.	2001.	-2286	-2286	728.	728.	-957.	-957.	0.	0.	264.	264.	-347.	-347.	0.	0.
	8306.	8306	-139.	-139.	121.	121.	1090.	1090.	-225.	-225.	-1211.	-1211.	3010.	3010.	-311.	-311.	-3342	-3342
7.5	119.	119.	2501.	2501.	-2858	-2858	910.	910.	-1197.	-1197.	0.	0.	330.	330.	-434.	-434.	0.	0.
	5817.	6817	-114.	-114.	100.	100.	895.	895.	-185.	-185.	-994.	-994.	2470.	2470.	-255.	-255.	-2743	-2743
9.0	143.	143.	3002.	3002.	-3430	-3430	1091.	1091.	-1436.	-1436.	0.	0.	395.	395.	-520.	-520.	0.	0.
	5824.	5823	-97.	-97.	85.	85.	765.	765.	-158.	-158.	-849.	-849.	2110.	2110.	-218.	-218.	-2343	-2343

GEAR LOADS AT MAXIMUM TRACKTIVE EFFORT CONDITION RUN DATE:No. 7-AUG-85:7

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
10.5	167.	167.	3502.	3502.	-4002	-4002	1273.	1273.	-1676.	-1676.	0.	0.	461.	461.	-607.	-607.	0.	0.
	5036.	5035	-84.	-84.	74.	74.	661.	661.	-137.	-137.	-734.	-734.	1824.	1824.	-188.	-188.	-2026	-2026
12.0	191.	191.	4002.	4002.	-4573	-4573	1455.	1455.	-1915.	-1915.	0.	0.	527.	527.	-694.	-694.	0.	0.
	4444.	4444	-74.	-74.	65.	65.	583.	583.	-121.	-121.	-648.	-648.	1610.	1610.	-166.	-166.	-1788	-1788
13.5	215.	215.	4502.	4502.	-5145	-5145	1637.	1637.	-2154.	-2154.	0.	0.	593.	593.	-781.	-781.	0.	0.
	3984.	3984	-67.	-67.	58.	58.	523.	523.	-108.	-108.	-581.	-581.	1444.	1444.	-149.	-149.	-1603	-1603
15.0	239.	239.	5003.	5003.	-5717	-5717	1819.	1819.	-2394.	-2394.	0.	0.	659.	659.	-867.	-867.	0.	0.
	3597.	3597	-60.	-60.	53.	53.	472.	472.	-98.	-98.	-524.	-524.	1303.	1303.	-135.	-135.	-1447	-1447
16.5	263.	263.	5503.	5503.	-6288	-6288	2001.	2001.	-2633.	-2633.	0.	0.	725.	725.	-954.	-954.	0.	0.
	3281.	3280	-55.	-55.	48.	48.	431.	431.	-89.	-89.	-478.	-478.	1189.	1189.	-123.	-123.	-1320	-1320
18.0	287.	287.	6003.	6003.	-6860	-6860	2183.	2183.	-2872.	-2872.	0.	0.	791.	791.	-1041.	-1041.	0.	0.
	3017.	3017	-50.	-50.	44.	44.	396.	396.	-82.	-82.	-440.	-440.	1093.	1093.	-113.	-113.	-1214	-1214
19.5	310.	310.	6503.	6503.	-7432	-7432	2365.	2365.	-3112.	-3112.	0.	0.	857.	857.	-1127.	-1127.	0.	0.
	2784.	2783	-47.	-47.	41.	41.	365.	365.	-75.	-75.	-406.	-406.	1009.	1009.	-104.	-104.	-1120	-1120
21.0	334.	334.	7004.	7004.	-8004	-8004	2547.	2547.	-3351.	-3351.	0.	0.	923.	923.	-1214.	-1214.	0.	0.
	2583.	2582	-43.	-43.	38.	38.	339.	339.	-70.	-70.	-377.	-377.	936.	936.	-97.	-97.	-1039	-1039
22.5	358.	358.	7504.	7504.	-8575	-8575	2729.	2729.	-3590.	-3590.	0.	0.	989.	989.	-1301.	-1301.	0.	0.
	2408.	2408	-40.	-40.	35.	35.	316.	316.	-65.	-65.	-351.	-351.	873.	873.	-90.	-90.	-969	-969
24.0	382.	382.	8004.	8004.	-9147	-9147	2911.	2911.	-3830.	-3830.	0.	0.	1055.	1055.	-1388.	-1388.	0.	0.
	2255.	2254	-38.	-38.	33.	33.	296.	296.	-61.	-61.	-329.	-329.	817.	817.	-84.	-84.	-907	-907
25.5	406.	406.	8504.	8504.	-9719	-9719	3093.	3093.	-4069.	-4069.	0.	0.	1120.	1120.	-1474.	-1474.	0.	0.
	2119.	2119	-35.	-35.	31.	31.	278.	278.	-57.	-57.	-309.	-309.	768.	768.	-79.	-79.	-852	-852
27.0	430.	430.	9005.	9005.	-10291	-10291	3274.	3274.	-4308.	-4308.	0.	0.	1186.	1186.	-1561.	-1561.	0.	0.
	1998.	1997	-33.	-33.	29.	29.	262.	262.	-54.	-54.	-291.	-291.	724.	724.	-75.	-75.	-803	-803

GEAR LOADS AT MAXIMUM TRACKTIVE EFFORT CONDITION RUN DATE:No. 7-AUG-85:7

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
28.5	454.	454.	9505.	9505.	-10862	-10862	3456.	3456.	-4548.	-4548.	0.	0.	1252.	1252.	-1648.	-1648.	0.	0.
	1888.	1888	-32.	-32.	28.	28.	248.	248.	-51.	-51.	-275.	-275.	684.	684.	-71.	-71.	-759	-759
30.0	478.	478.	10005.	10005.	-11434	-11434	3638.	3638.	-4787.	-4787.	0.	0.	1318.	1318.	-1734.	-1734.	0.	0.
	1790.	1789	-30.	-30.	26.	26.	235.	235.	-49.	-49.	-261.	-261.	648.	648.	-67.	-67.	-720	-720
31.5	501.	501.	10505.	10505.	-12006	-12006	3820.	3820.	-5027.	-5027.	0.	0.	1384.	1384.	-1821.	-1821.	0.	0.
	1700.	1699	-28.	-28.	25.	25.	223.	223.	-46.	-46.	-248.	-248.	616.	616.	-64.	-64.	-683	-683
33.0	525.	525.	11006.	11006.	-12577	-12577	4002.	4002.	-5266.	-5266.	0.	0.	1450.	1450.	-1908.	-1908.	0.	0.
	1615.	1614	-27.	-27.	24.	24.	212.	212.	-44.	-44.	-235.	-235.	585.	585.	-60.	-60.	-649	-649
34.5	549.	549.	11506.	11506.	-13149	-13149	4184.	4184.	-5505.	-5505.	0.	0.	1516.	1516.	-1995.	-1995.	0.	0.
	1537.	1536	-26.	-26.	22.	22.	202.	202.	-42.	-42.	-224.	-224.	557.	557.	-58.	-58.	-618	-618
36.0	573.	573.	12006.	12006.	-13721	-13721	4366.	4366.	-5745.	-5745.	0.	0.	1582.	1582.	-2081.	-2081.	0.	0.
	1465.	1464	-24.	-24.	21.	21.	192.	192.	-40.	-40.	-214.	-214.	531.	531.	-55.	-55.	-589	-589
37.5	597.	597.	12507.	12507.	-14293	-14293	4548.	4548.	-5984.	-5984.	0.	0.	1648.	1648.	-2168.	-2168.	0.	0.
	1397.	1396	-23.	-23.	20.	20.	183.	183.	-38.	-38.	-204.	-204.	506.	506.	-52.	-52.	-561	-561
39.0	621.	621.	13007.	13007.	-14864	-14864	4730.	4730.	-6223.	-6223.	0.	0.	1714.	1714.	-2255.	-2255.	0.	0.
	1335.	1335	-22.	-22.	20.	20.	175.	175.	-36.	-36.	-195.	-195.	484.	484.	-50.	-50.	-537	-537
40.5	645.	645.	13507.	13507.	-15436	-15436	4912.	4912.	-6463.	-6463.	0.	0.	1780.	1780.	-2342.	-2342.	0.	0.
	1275.	1275	-21.	-21.	19.	19.	167.	167.	-35.	-35.	-186.	-186.	462.	462.	-48.	-48.	-513	-513
42.0	669.	669.	14007.	14007.	-16008	-16008	5094.	5094.	-6702.	-6702.	0.	0.	1845.	1845.	-2428.	-2428.	0.	0.
	1219.	1219	-20.	-20.	18.	18.	160.	160.	-33.	-33.	-178.	-178.	442.	442.	-46.	-46.	-490	-490
43.5	693.	693.	14508.	14508.	-16580	-16580	5275.	5275.	-6941.	-6941.	0.	0.	1911.	1911.	-2515.	-2515.	0.	0.
	1167.	1167	-20.	-20.	17.	17.	153.	153.	-32.	-32.	-170.	-170.	423.	423.	-44.	-44.	-469	-469
45.0	716.	716.	15008.	15008.	-17151	-17151	5457.	5457.	-7181.	-7181.	0.	0.	1977.	1977.	-2602.	-2602.	0.	0.
	1119.	1118	-19.	-19.	16.	16.	147.	147.	-30.	-30.	-163.	-163.	405.	405.	-42.	-42.	-450	-450

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION — BY: RICK LEWIS; REVISION: 8-JUN-85

RUN DATE: 20-AUG-85;109

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 40.0 MAXIMUM VELOCITY, mph = 45.0 ENGINE NET HP. = 880.0

TRACK PITCH, in. = 7.63 NUMBER OF SPROCKET TEETH = 11

Efficiency data for Westinghouse induction motor by Craig Joseph 10-MAY-85

CONFIGURATION I

TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK	OUTER SPROK	INNER MOTOR=A	OUTER MOTOR=A	INNER B	OUTER B	INNER C & D	OUTER C & D	INNER E	OUTER E	INNER F	OUTER F
	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftxlbs	RPM / TORQUE ftlbs	RPM / TORQUE ftlbs
	19.	19.	395.	395.	-121.	-121.	-33.	-33.	87.	87.	19.	19.
	53424.	53424.	2706.	2705.	-9013.	-9013.	-30292.	-30292.	2891.	2891.	6109.	6114.
	38.	38.	790.	790.	-242.	-242.	-67.	-67.	174.	174.	38.	38.
	39569.	39569.	2004.	2003.	-6676.	-6576.	-22436.	-22436.	2142.	2142.	4525.	4529.
4.5	57.	57.	1186.	1186.	-364.	-364.	-100.	-100.	262.	262.	57.	57.
	28328.	28328.	1435.	1434.	-4779.	-4779.	-16062.	-16062.	1533.	1533.	3239.	3242.
6.0	76.	76.	1581.	1581.	-485.	-485.	-133.	-133.	349.	349.	76.	76.
	22120.	22120.	1120.	1120.	-3732.	-3732.	-12542.	-12542.	1197.	1197.	2529.	2532.
7.5	94.	94.	1976.	1976.	-606.	-606.	-167.	-167.	436.	436.	94.	94.
	18085.	18085.	916.	916.	-3051.	-3051.	-10255.	-10255.	979.	979.	2068.	2070.
9.0	113.	113.	2371.	2371.	-727.	-727.	-200.	-200.	523.	523.	113.	113.
	15397.	15397.	780.	780.	-2598.	-2598.	-8730.	-8730.	833.	833.	1761.	1762.

GEAR LOADS AT MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 20-AUG-85:109

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
10.5	132.	132.	2766.	2766.	-848.	-848.	-233.	-233.	611.	611.	132.	132.
	13439.	13439.	681.	680.	-2267.	-2267.	-7620.	-7620.	727.	727.	1537.	1538.
12.0	151.	151.	3162.	3162.	-970.	-970.	-266.	-266.	698.	698.	151.	151.
	11824.	11824.	599.	599.	-1995.	-1995.	-6704.	-6704.	640.	640.	1352.	1353.
13.5	170.	170.	3557.	3557.	-1091.	-1091.	-300.	-300.	785.	785.	170.	170.
	10568.	10568.	535.	535.	-1783.	-1783.	-5992.	-5992.	572.	572.	1208.	1209.
15.0	189.	189.	3952.	3952.	-1212.	-1212.	-333.	-333.	872.	872.	189.	189.
	9563.	9563.	484.	484.	-1613.	-1613.	-5422.	-5422.	518.	518.	1094.	1094.
16.5	208.	208.	4347.	4347.	-1333.	-1333.	-366.	-366.	960.	960.	208.	208.
	8741.	8741.	443.	443.	-1475.	-1475.	-4956.	-4956.	473.	473.	1000.	1000.
	227.	227.	4743.	4743.	-1454.	-1454.	-400.	-400.	1047.	1047.	227.	227.
	8056.	8056.	408.	408.	-1359.	-1359.	-4568.	-4568.	436.	436.	921.	922.
	246.	246.	5138.	5138.	-1575.	-1575.	-433.	-433.	1134.	1134.	246.	246.
	7436.	7436.	377.	376.	-1254.	-1254.	-4216.	-4216.	402.	402.	850.	851.
21.0	264.	264.	5533.	5533.	-1697.	-1697.	-466.	-466.	1221.	1221.	264.	264.
	6903.	6903.	350.	349.	-1165.	-1165.	-3914.	-3914.	374.	374.	789.	790.
22.5	283.	283.	5928.	5928.	-1818.	-1818.	-500.	-500.	1308.	1308.	283.	283.
	6442.	6442.	326.	326.	-1087.	-1087.	-3652.	-3652.	349.	349.	737.	737.
24.0	302.	302.	6323.	6323.	-1939.	-1939.	-533.	-533.	1396.	1396.	302.	302.
	6038.	6038.	306.	306.	-1019.	-1019.	-3424.	-3424.	327.	327.	690.	691.
25.5	321.	321.	6719.	6719.	-2060.	-2060.	-566.	-566.	1483.	1483.	321.	321.
	5682.	5682.	288.	288.	-959.	-959.	-3222.	-3222.	308.	308.	650.	650.
27.0	340.	340.	7114.	7114.	-2181.	-2181.	-600.	-600.	1570.	1570.	340.	340.
	5365.	5365.	272.	272.	-905.	-905.	-3042.	-3042.	290.	290.	613.	614.

GEAR LOADS AT MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 20-AUG-85;109

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	INNER MOTOR=A RPM / TORQUE ftxlbs	OUTER MOTOR=A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C & D RPM / TORQUE ftxlbs	OUTER C & D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftlbs	OUTER F RPM / TORQUE ftlbs
28.5	359.	359.	7509.	7509.	-2303.	-2303.	-633.	-633.	1657.	1657.	359.	359.
	5082.	5082.	257.	257.	-857.	-857.	-2881.	-2881.	275.	275.	581.	582.
30.0	378.	378.	7904.	7904.	-2424.	-2424.	-666.	-666.	1745.	1745.	378.	378.
	4826.	4826.	244.	244.	-814.	-814.	-2737.	-2737.	261.	261.	552.	552.
31.5	397.	397.	8299.	8299.	-2545.	-2545.	-699.	-699.	1832.	1832.	397.	397.
	4596.	4596.	233.	233.	-775.	-775.	-2606.	-2606.	249.	249.	526.	526.
33.0	415.	415.	8695.	8695.	-2666.	-2666.	-733.	-733.	1919.	1919.	415.	415.
	4386.	4386.	222.	222.	-740.	-740.	-2487.	-2487.	237.	237.	502.	502.
34.5	434.	434.	9090.	9090.	-2787.	-2787.	-766.	-766.	2006.	2006.	434.	434.
	4194.	4194.	212.	212.	-708.	-708.	-2378.	-2378.	227.	227.	480.	480.
	453.	453.	9485.	9485.	-2909.	-2909.	-799.	-799.	2094.	2094.	453.	453.
	4019.	4019.	204.	203.	-678.	-678.	-2279.	-2279.	218.	218.	460.	460.
[illegible]	472.	472.	9880.	9880.	-3030.	-3030.	-833.	-833.	2181.	2181.	472.	472.
	3850.	3850.	195.	195.	-650.	-650.	-2183.	-2183.	208.	208.	440.	441.
39.0	491.	491.	10275.	10275.	-3151.	-3151.	-866.	-866.	2268.	2268.	491.	491.
	3694.	3694.	187.	187.	-623.	-623.	-2094.	-2094.	200.	200.	422.	423.
40.5	510.	510.	10671.	10671.	-3272.	-3272.	-899.	-899.	2355.	2355.	510.	510.
	3549.	3549.	180.	180.	-599.	-599.	-2013.	-2013.	192.	192.	406.	406.
42.0	529.	529.	11066.	11066.	-3393.	-3393.	-933.	-933.	2442.	2442.	529.	529.
	3415.	3415.	173.	173.	-576.	-576.	-1936.	-1936.	185.	185.	391.	391.
43.5	548.	548.	11461.	11461.	-3515.	-3515.	-966.	-966.	2530.	2530.	548.	548.
	3290.	3290.	167.	167.	-555.	-555.	-1866.	-1866.	178.	178.	376.	377.
45.0	567.	567.	11856.	11856.	-3636.	-3636.	-999.	-999.	2617.	2617.	567.	567.
	3174.	3174.	161.	161.	-535.	-535.	-1800.	-1800.	172.	172.	363.	363.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION BY: RICK LEWIS; REVISION: 8-JUN-85
RUN DATE: 14-AUG-85;110

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 40.0 MAXIMUM VELOCITY, mph = 45.0 ENGINE NET HP. = 880.0
TRACK PITCH, in. = 7.63 NUMBER OF SPROCKET TEETH = 11

Efficiency data for Westinghouse induction motor by Craig Joseph 10-MAY-85

CONFIGURATION II
PROPULSION/STEER MOTOR SET-UP

MAX VEH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
MPH	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
1.5	19.	19.	398.	243.	243.	0.	0.	76.	76.	-38.	-38.	0.	0.	0.	0.	0.	0.	0.
	53424.	53424.	2610.	-32.	-32.	10821.	10821.	13556.	13556.	-67.	-67.	39467.	39467.	-6652.	10885.	85266.	35074.	-9163.
3.0	38.	38.	797.	487.	487.	0.	0.	151.	151.	-76.	-76.	0.	0.	0.	0.	0.	0.	0.
	38727.	38727.	1892.	-23.	-23.	7844.	7844.	9827.	9827.	-48.	-48.	28609.	28609.	-4822.	7891.	61809.	25425.	-6643.
4.5	57.	57.	1195.	730.	730.	0.	0.	227.	227.	-113.	-113.	0.	0.	0.	0.	0.	0.	0.
	27725.	27725.	1354.	-16.	-16.	5616.	5616.	7035.	7035.	-35.	-35.	20482.	20482.	-3452.	5649.	44250.	18202.	-4755.
6.0	76.	76.	1593.	974.	974.	0.	0.	302.	302.	-151.	-151.	0.	0.	0.	0.	0.	0.	0.
	21649.	21649.	1057.	-13.	-13.	4385.	4385.	5493.	5493.	-27.	-27.	15993.	15993.	-2696.	4411.	34553.	14213.	-3713.
7.5	94.	94.	1991.	1217.	1217.	0.	0.	378.	378.	-189.	-189.	0.	0.	0.	0.	0.	0.	0.
	17701.	17701.	865.	-10.	-10.	3585.	3585.	4492.	4492.	-22.	-22.	13076.	13076.	-2204.	3606.	28251.	11621.	-3036.
9.0	113.	113.	2390.	1460.	1460.	0.	0.	453.	453.	-227.	-227.	0.	0.	0.	0.	0.	0.	0.
	15070.	15070.	736.	-9.	-9.	3052.	3052.	3824.	3824.	-19.	-19.	11133.	11133.	-1876.	3070.	24052.	9894.	-2595.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 14-AUG-85:110

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQUE ftxlbs	PROP MOTOR RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	STEER MOTOR RPM / TORQUE ftxlbs	H RPM / TORQUE ftxlbs	J RPM / TORQUE ftxlbs	K RPM / TORQUE ftxlbs	L RPM / TORQUE ftxlbs
10.5	132.	132.	2788.	1704.	1704.	0.	0.	529.	529.	-264.	-264.	0.	0.	0.	0.	0.	0.	0.
	13153.	13153.	642.	-8.	-8.	2664.	2664.	3338.	3338.	-16.	-16.	9717.	9717.	-1638.	2680.	20992.	8635.	-2256.
12.0	151.	151.	3186.	1947.	1947.	0.	0.	604.	604.	-302.	-302.	0.	0.	0.	0.	0.	0.	0.
	11572.	11572.	565.	-7.	-7.	2344.	2344.	2936.	2936.	-14.	-14.	8549.	8549.	-1441.	2358.	18470.	7597.	-1985.
13.5	170.	170.	3585.	2191.	2191.	0.	0.	680.	680.	-340.	-340.	0.	0.	0.	0.	0.	0.	0.
	10343.	10343.	505.	-6.	-6.	2095.	2095.	2625.	2625.	-13.	-13.	7641.	7641.	-1288.	2107.	16508.	6790.	-1774.
15.0	189.	189.	3983.	2434.	2434.	0.	0.	755.	755.	-378.	-378.	0.	0.	0.	0.	0.	0.	0.
	9360.	9360.	457.	-6.	-6.	1896.	1896.	2375.	2375.	-12.	-12.	6915.	6915.	-1165.	1907.	14939.	6145.	-1605.
16.5	208.	208.	4381.	2677.	2677.	0.	0.	831.	831.	-415.	-415.	0.	0.	0.	0.	0.	0.	0.
	8555.	8555.	418.	-5.	-5.	1733.	1733.	2171.	2171.	-11.	-11.	6320.	6320.	-1065.	1743.	13655.	5617.	-1467.
18.0	227.	227.	4779.	2921.	2921.	0.	0.	906.	906.	-453.	-453.	0.	0.	0.	0.	0.	0.	0.
	7885.	7885.	385.	-5.	-5.	1597.	1597.	2001.	2001.	-10.	-10.	5825.	5825.	-982.	1607.	12585.	5177.	-1352.
19.5	246.	246.	5178.	3164.	3164.	0.	0.	982.	982.	-491.	-491.	0.	0.	0.	0.	0.	0.	0.
	7277.	7277.	355.	-4.	-4.	1474.	1474.	1847.	1847.	-9.	-9.	5376.	5376.	-906.	1483.	11615.	4778.	-1248.
21.0	264.	264.	5576.	3408.	3408.	0.	0.	1058.	1058.	-529.	-529.	0.	0.	0.	0.	0.	0.	0.
	6756.	6756.	330.	-4.	-4.	1368.	1368.	1714.	1714.	-8.	-8.	4991.	4991.	-841.	1377.	10783.	4436.	-1159.
22.5	283.	283.	5974.	3651.	3651.	0.	0.	1133.	1133.	-567.	-567.	0.	0.	0.	0.	0.	0.	0.
	6305.	6305.	308.	-4.	-4.	1277.	1277.	1600.	1600.	-8.	-8.	4658.	4658.	-785.	1285.	10062.	4139.	-1081.
24.0	302.	302.	6373.	3894.	3894.	0.	0.	1209.	1209.	-604.	-604.	0.	0.	0.	0.	0.	0.	0.
	5909.	5909.	289.	-3.	-3.	1197.	1197.	1500.	1500.	-7.	-7.	4366.	4366.	-736.	1204.	9432.	3880.	-1014.
25.5	321.	321.	6771.	4138.	4138.	0.	0.	1284.	1284.	-642.	-642.	0.	0.	0.	0.	0.	0.	0.
	5561.	5561.	272.	-3.	-3.	1126.	1126.	1411.	1411.	-7.	-7.	4108.	4108.	-692.	1133.	8875.	3651.	-954.
27.0	340.	340.	7169.	4381.	4381.	0.	0.	1360.	1360.	-680.	-680.	0.	0.	0.	0.	0.	0.	0.
	5251.	5251.	256.	-3.	-3.	1063.	1063.	1332.	1332.	-7.	-7.	3879.	3879.	-654.	1070.	8380.	3447.	-901.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION RUN DATE:No. 14-AUG-85:110

MAX VEH MPH	INNER SPROK	OUTER SPROK	PROP MOTOR	OUTER B	INNER B	OUTER C	INNER C	OUTER D	INNER D	OUTER E	INNER E	OUTER F	INNER F	STEER MOTOR	H	J	K	L
	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
28.5	359.	359.	7568.	4625.	4625.	0.	0.	1435.	1435.	-718.	-718.	0.	0.	0.	0.	0.	0.	0.
	4973.	4973.	243.	-3.	-3.	1007.	1007.	1262.	1262.	-6.	-6.	3674.	3674.	-619.	1013.	7938.	3265.	-853.
30.0	378.	378.	7966.	4868.	4868.	0.	0.	1511.	1511.	-755.	-755.	0.	0.	0.	0.	0.	0.	0.
	4724.	4724.	231.	-3.	-3.	957.	957.	1199.	1199.	-6.	-6.	3490.	3490.	-588.	962.	7539.	3101.	-810.
31.5	397.	397.	8364.	5111.	5111.	0.	0.	1586.	1586.	-793.	-793.	0.	0.	0.	0.	0.	0.	0.
	4498.	4498.	220.	-3.	-3.	911.	911.	1141.	1141.	-6.	-6.	3323.	3323.	-560.	916.	7179.	2953.	-772.
33.0	415.	415.	8762.	5355.	5355.	0.	0.	1662.	1662.	-831.	-831.	0.	0.	0.	0.	0.	0.	0.
	4293.	4293.	210.	-3.	-3.	869.	869.	1089.	1089.	-5.	-5.	3171.	3171.	-535.	875.	6851.	2818.	-736.
34.5	434.	434.	9161.	5598.	5598.	0.	0.	1737.	1737.	-869.	-869.	0.	0.	0.	0.	0.	0.	0.
	4105.	4105.	201.	-2.	-2.	831.	831.	1042.	1042.	-5.	-5.	3033.	3033.	-511.	836.	6552.	2695.	-704.
36.0	453.	453.	9559.	5842.	5842.	0.	0.	1813.	1813.	-906.	-906.	0.	0.	0.	0.	0.	0.	0.
	3933.	3933.	192.	-2.	-2.	797.	797.	998.	998.	-5.	-5.	2906.	2906.	-490.	801.	6278.	2582.	-675.
37.5	472.	472.	9957.	6085.	6085.	0.	0.	1889.	1889.	-944.	-944.	0.	0.	0.	0.	0.	0.	0.
	3768.	3768.	184.	-2.	-2.	763.	763.	956.	956.	-5.	-5.	2784.	2784.	-469.	768.	6014.	2474.	-646.
39.0	491.	491.	10356.	6328.	6328.	0.	0.	1964.	1964.	-982.	-982.	0.	0.	0.	0.	0.	0.	0.
	3615.	3615.	177.	-2.	-2.	732.	732.	917.	917.	-5.	-5.	2671.	2671.	-450.	737.	5770.	2373.	-620.
40.5	510.	510.	10754.	6572.	6572.	0.	0.	2040.	2040.	-1020.	-1020.	0.	0.	0.	0.	0.	0.	0.
	3474.	3474.	170.	-2.	-2.	704.	704.	881.	881.	-4.	-4.	2566.	2566.	-433.	708.	5544.	2281.	-596.
42.0	529.	529.	11152.	6815.	6815.	0.	0.	2115.	2115.	-1058.	-1058.	0.	0.	0.	0.	0.	0.	0.
	3343.	3343.	163.	-2.	-2.	677.	677.	848.	848.	-4.	-4.	2469.	2469.	-416.	681.	5335.	2194.	-573.
43.5	548.	548.	11550.	7059.	7059.	0.	0.	2191.	2191.	-1095.	-1095.	0.	0.	0.	0.	0.	0.	0.
	3220.	3220.	157.	-2.	-2.	652.	652.	817.	817.	-4.	-4.	2379.	2379.	-401.	656.	5140.	2114.	-552.
45.0	567.	567.	11949.	7302.	7302.	0.	0.	2266.	2266.	-1133.	-1133.	0.	0.	0.	0.	0.	0.	0.
	3106.	3106.	152.	-2.	-2.	629.	629.	788.	788.	-4.	-4.	2295.	2295.	-387.	633.	4958.	2039.	-533.

GEAR LOADS DURING MAXIMUM TRACTIVE EFFORT CONDITION BY: RICK LEWIS; REVISION: 8-JUN-85
RUN DATE: 14-AUG-85;108

INPUT DATA:

GROSS VEHICLE WEIGHT, tons = 40.0 MAXIMUM VELOCITY, mph = 45.0 ENGINE NET HP. = 880.0
TRACK PITCH, in. = 7.63 NUMBER OF SPRUCKET TEETH = 11

Efficiency data for Homopolar motor * CONFIGURATION I
by Gene Siedler 20-MAY-85 * TWIN DRIVE MOTOR SET-UP

MAX VEH MPH	INNER SPROK RPM	OUTER SPROK RPM	INNER MOTOR RPM	OUTER MOTOR RPM	INNER A RPM	OUTER A RPM	INNER B RPM	OUTER B RPM	INNER C RPM	OUTER C RPM	INNER D RPM	OUTER D RPM	INNER E RPM	OUTER E RPM	INNER F RPM	OUTER F RPM	INNER G RPM	OUTER G RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
1.5	19.	19.	396.	396.	-452	-452	144.	144.	-189.	-189.	0.	0.	52.	52.	-69.	-69.	0.	0.
	48413.	48412	-809.	-809.	708.	708.	6355.	6355.	-1313.	-1313.	-7058.	-7058.	17541.	17541.	-1812.	-1812.	-19480	-19480
3.0	38.	38.	791.	791.	-904	-904	288.	288.	-379.	-379.	0.	0.	104.	104.	-137.	-137.	0.	0.
	38656.	38655	-646.	-646.	565.	565.	5075.	5075.	-1048.	-1048.	-5636.	-5636.	14006.	14006.	-1447.	-1447.	-15554	-15554
4.5	57.	57.	1187.	1187.	-1356	-1356	432.	432.	-568.	-568.	0.	0.	156.	156.	-206.	-206.	0.	0.
	27349.	27349	-457.	-457.	400.	400.	3590.	3590.	-742.	-742.	-3987.	-3987.	9909.	9909.	-1024.	-1024.	-11004	-11004
6.0	76.	76.	1582.	1582.	-1808	-1808	575.	575.	-757.	-757.	0.	0.	208.	208.	-274.	-274.	0.	0.
	21057.	21056	-352.	-352.	308.	308.	2764.	2764.	-571.	-571.	-3070.	-3070.	7629.	7629.	-788.	-788.	-8472	-8472
7.5	94.	94.	1978.	1978.	-2260	-2260	719.	719.	-946.	-946.	0.	0.	261.	261.	-343.	-343.	0.	0.
	17285.	17285	-289.	-289.	253.	253.	2269.	2269.	-469.	-469.	-2520.	-2520.	6263.	6263.	-647.	-647.	-6955	-6955
9.0	113.	113.	2374.	2374.	-2712	-2712	863.	863.	-1136.	-1136.	0.	0.	313.	313.	-411.	-411.	0.	0.
	14772.	14771	-247.	-247.	216.	216.	1939.	1939.	-401.	-401.	-2154.	-2154.	5352.	5352.	-553.	-553.	-5943	-5943

GEAR LOADS AT MAXIMUM TRACKTIVE EFFORT CONDITION RUN DATE:No. 14-AUG-85;108

MAX VEH	INNER SPROK	OUTER SPROK	INNER MOTOR	OUTER MOTOR	INNER A	OUTER A	INNER B	OUTER B	INNER C	OUTER C	INNER D	OUTER D	INNER E	OUTER E	INNER F	OUTER F	INNER G	OUTER G
MPH	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM
	TORQUE ftxlbs	TORQU ftlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs	TORQUE ftxlbs
10.5	132.	132.	2769.	2769.	-3164	-3164	1007.	1007.	-1325.	-1325.	0.	0.	365.	365.	-480.	-480.	0.	0.
	12776.	12775	-213.	-213.	187.	187.	1677.	1677.	-346.	-346.	-1863.	-1863.	4629.	4629.	-478.	-478.	-5140	-5140
12.0	151.	151.	3165.	3165.	-3617	-3617	1151.	1151.	-1514.	-1514.	0.	0.	417.	417.	-549.	-549.	0.	0.
	11279.	11279	-188.	-188.	165.	165.	1481.	1481.	-306.	-306.	-1644.	-1644.	4087.	4087.	-422.	-422.	-4538	-4538
13.5	170.	170.	3561.	3561.	-4069	-4069	1295.	1295.	-1704.	-1704.	0.	0.	469.	469.	-617.	-617.	0.	0.
	10115.	10114	-169.	-169.	148.	148.	1328.	1328.	-274.	-274.	-1475.	-1475.	3665.	3665.	-379.	-379.	-4070	-4070
15.0	189.	189.	3956.	3956.	-4521	-4521	1439.	1439.	-1893.	-1893.	0.	0.	521.	521.	-686.	-686.	0.	0.
	9137.	9136	-153.	-153.	134.	134.	1199.	1199.	-248.	-248.	-1332.	-1332.	3310.	3310.	-342.	-342.	-3676	-3676
16.5	208.	208.	4352.	4352.	-4973	-4973	1582.	1582.	-2082.	-2082.	0.	0.	573.	573.	-754.	-754.	0.	0.
	8337.	8336	-139.	-139.	122.	122.	1094.	1094.	-226.	-226.	-1215.	-1215.	3021.	3021.	-312.	-312.	-3354	-3354
18.0	227.	227.	4747.	4747.	-5425	-5425	1726.	1726.	-2271.	-2271.	0.	0.	625.	625.	-823.	-823.	0.	0.
	7670.	7670	-128.	-128.	112.	112.	1007.	1007.	-208.	-208.	-1118.	-1118.	2779.	2779.	-287.	-287.	-3086	-3086
19.5	246.	246.	5143.	5143.	-5877	-5877	1870.	1870.	-2461.	-2461.	0.	0.	678.	678.	-892.	-892.	0.	0.
	7080.	7079	-118.	-118.	104.	104.	929.	929.	-192.	-192.	-1032.	-1032.	2565.	2565.	-265.	-265.	-2848	-2848
21.0	264.	264.	5539.	5539.	-6329	-6329	2014.	2014.	-2650.	-2650.	0.	0.	730.	730.	-960.	-960.	0.	0.
	6573.	6572	-110.	-110.	96.	96.	863.	863.	-178.	-178.	-958.	-958.	2381.	2381.	-246.	-246.	-2644	-2644
22.5	283.	283.	5934.	5934.	-6781	-6781	2158.	2158.	-2839.	-2839.	0.	0.	782.	782.	-1029.	-1029.	0.	0.
	6133.	6133	-102.	-102.	90.	90.	805.	805.	-166.	-166.	-894.	-894.	2222.	2222.	-230.	-230.	-2467	-2467
24.0	302.	302.	6330.	6330.	-7234	-7234	2302.	2302.	-3029.	-3029.	0.	0.	834.	834.	-1097.	-1097.	0.	0.
	5746.	5746	-96.	-96.	84.	84.	754.	754.	-156.	-156.	-838.	-838.	2082.	2082.	-215.	-215.	-2312	-2312
25.5	321.	321.	6725.	6725.	-7686	-7686	2446.	2446.	-3218.	-3218.	0.	0.	886.	886.	-1166.	-1166.	0.	0.
	5404.	5404	-90.	-90.	79.	79.	709.	709.	-147.	-147.	-788.	-788.	1958.	1958.	-202.	-202.	-2174	-2174
27.0	340.	340.	7121.	7121.	-8138	-8138	2589.	2589.	-3407.	-3407.	0.	0.	938.	938.	-1234.	-1234.	0.	0.
	5099.	5099	-85.	-85.	75.	75.	669.	669.	-138.	-138.	-743.	-743.	1848.	1848.	-191.	-191.	-2051	-2051

GEAR LOADS AT MAXIMUM TRACKTIVE EFFORT CONDITION RUN DATE:No. 14-AUG-85:108

MAX VEH MPH	INNER SPROK RPM / TORQUE ftxlbs	OUTER SPROK RPM / TORQU ftlbs	INNER MOTOR RPM / TORQUE ftxlbs	OUTER MOTOR RPM / TORQUE ftxlbs	INNER A RPM / TORQUE ftxlbs	OUTER A RPM / TORQUE ftxlbs	INNER B RPM / TORQUE ftxlbs	OUTER B RPM / TORQUE ftxlbs	INNER C RPM / TORQUE ftxlbs	OUTER C RPM / TORQUE ftxlbs	INNER D RPM / TORQUE ftxlbs	OUTER D RPM / TORQUE ftxlbs	INNER E RPM / TORQUE ftxlbs	OUTER E RPM / TORQUE ftxlbs	INNER F RPM / TORQUE ftxlbs	OUTER F RPM / TORQUE ftxlbs	INNER G RPM / TORQUE ftxlbs	OUTER G RPM / TORQUE ftxlbs
28.5	359.	359.	7517.	7517.	-8590	-8590	2733.	2733.	-3597.	-3597.	0.	0.	990.	990.	-1303.	-1303.	0.	0.
	4824.	4824	-81.	-81.	71.	71.	633.	633.	-131.	-131.	-703.	-703.	1748.	1748.	-181.	-181.	-1941	-1941
30.0	378.	378.	7912.	7912.	-9042	-9042	2877.	2877.	-3786.	-3786.	0.	0.	1042.	1042.	-1372.	-1372.	0.	0.
	4577.	4576	-76.	-76.	67.	67.	601.	601.	-124.	-124.	-667.	-667.	1658.	1658.	-171.	-171.	-1841	-1841
31.5	397.	397.	8308.	8308.	-9494	-9494	3021.	3021.	-3975.	-3975.	0.	0.	1095.	1095.	-1440.	-1440.	0.	0.
	4352.	4351	-73.	-73.	64.	64.	571.	571.	-118.	-118.	-634.	-634.	1577.	1577.	-163.	-163.	-1751	-1751
33.0	415.	415.	8704.	8704.	-9946	-9946	3165.	3165.	-4164.	-4164.	0.	0.	1147.	1147.	-1509.	-1509.	0.	0.
	4139.	4139	-69.	-69.	61.	61.	543.	543.	-112.	-112.	-603.	-603.	1500.	1500.	-155.	-155.	-1665	-1665
34.5	434.	434.	9099.	9099.	-10399	-10399	3309.	3309.	-4354.	-4354.	0.	0.	1199.	1199.	-1577.	-1577.	0.	0.
	3945.	3945	-66.	-66.	58.	58.	518.	518.	-107.	-107.	-575.	-575.	1430.	1430.	-148.	-148.	-1587	-1587
36.0	453.	453.	9495.	9495.	-10851	-10851	3453.	3453.	-4543.	-4543.	0.	0.	1251.	1251.	-1646.	-1646.	0.	0.
	3766.	3766	-63.	-63.	55.	55.	494.	494.	-102.	-102.	-549.	-549.	1365.	1365.	-141.	-141.	-1515	-1515
37.5	472.	472.	9890.	9890.	-11303	-11303	3597.	3597.	-4732.	-4732.	0.	0.	1303.	1303.	-1715.	-1715.	0.	0.
	3598.	3597	-60.	-60.	53.	53.	472.	472.	-98.	-98.	-525.	-525.	1304.	1304.	-135.	-135.	-1447	-1447
39.0	491.	491.	10286.	10286.	-11755	-11755	3740.	3740.	-4922.	-4922.	0.	0.	1355.	1355.	-1783.	-1783.	0.	0.
	3444.	3444	-58.	-58.	50.	50.	452.	452.	-93.	-93.	-502.	-502.	1248.	1248.	-129.	-129.	-1385	-1385
40.5	510.	510.	10682.	10682.	-12207	-12207	3884.	3884.	-5111.	-5111.	0.	0.	1407.	1407.	-1852.	-1852.	0.	0.
	3298.	3298	-55.	-55.	48.	48.	433.	433.	-89.	-89.	-481.	-481.	1195.	1195.	-123.	-123.	-1327	-1327
42.0	529.	529.	11077.	11077.	-12659	-12659	4028.	4028.	-5300.	-5300.	0.	0.	1459.	1459.	-1920.	-1920.	0.	0.
	3161.	3160	-53.	-53.	46.	46.	415.	415.	-86.	-86.	-461.	-461.	1145.	1145.	-118.	-118.	-1271	-1271
43.5	548.	548.	11473.	11473.	-13111	-13111	4172.	4172.	-5489.	-5489.	0.	0.	1512.	1512.	-1989.	-1989.	0.	0.
	3033.	3033	-51.	-51.	44.	44.	398.	398.	-82.	-82.	-442.	-442.	1099.	1099.	-114.	-114.	-1220	-1220
45.0	567.	567.	11868.	11868.	-13563	-13563	4316.	4316.	-5679.	-5679.	0.	0.	1564.	1564.	-2057.	-2057.	0.	0.
	2914.	2914	-49.	-49.	43.	43.	383.	383.	-79.	-79.	-425.	-425.	1056.	1056.	-109.	-109.	-1172	-1172

B.3 Regeneration In Steering

The effects of regeneration efficiency on steering performance were studied to quantify significance on this factor. The following curves illustrate the results of this study. The 19.5 ton vehicle parameters were used. The propulsive efficiency of the drive was based on the homopolar system, which is only slightly lower than the induction motor systems. Regeneration efficiency was varied as noted to determine the effects.

1. Figure B.3-1: These curves show that regeneration efficiencies of 60% or better will provide the same minimum turn radius.

2. Figure B.3-2: These curves show that regeneration efficiencies of 60% or better will provide the 0.5 G. lateral acceleration that is desirable for evasive maneuvers.

3. Figure B.3-3: These curves show that power requirements in turns decreases with improved regeneration efficiency, which will reduce fuel consumption.

4. Figure B.3-4: These curves show that improved regeneration efficiency increases outer sprocket maximum loads, potentially increasing the required size of motors and related gearing.

5. Figure B.3-5: These curves show that regeneration horsepower is constant with regeneration efficiencies of 60% or greater.

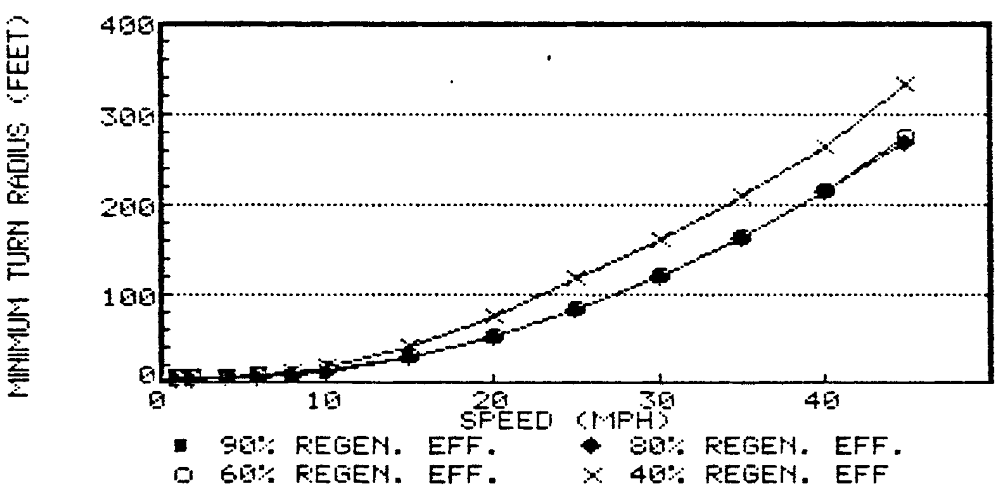
6. Figure B.3-6: These curves show regeneration efficiency indirectly changes scrub horsepower due to more scrubbing in the sharper turn.

7. Figure B.3-7: These curves show the effect of sharper turns on regenerated horsepower at 90% regeneration efficiency and that the resulting higher powers impose greater loads on system components.

The conclusion from the data provided by these curves was that regeneration efficiencies of 60% or better would provide satisfactory performance. Since all recommended drives provided the desired level of regeneration efficiency, this characteristic did not become a factor for discriminating between the various drives.

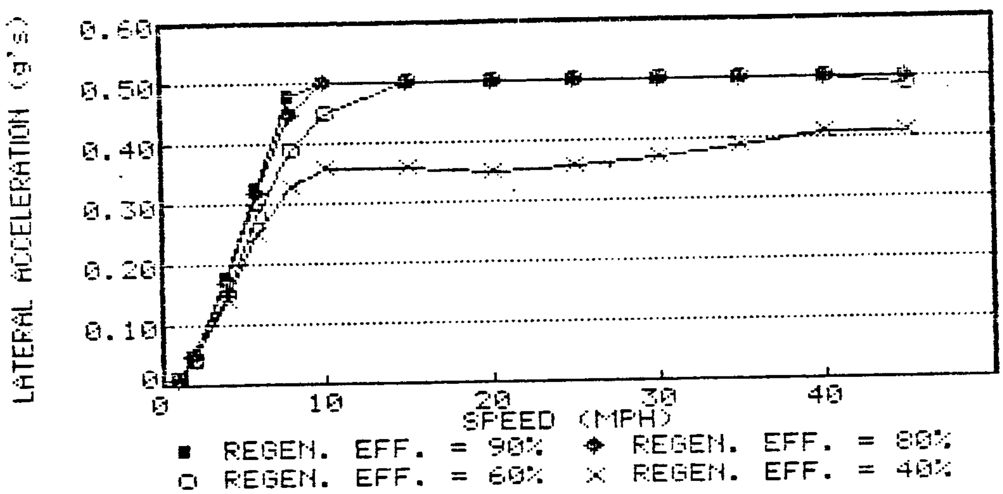
X Data	90% REGEN. EFF.	80% REGEN. EFF.	60% REGEN. EFF.	40% REGEN. EFF.
1	5.28	5.48	5.88	6.29
2	5.31	5.50	6.06	6.62
4	6.06	6.38	7.02	7.86
6	7.20	7.61	8.58	9.81
8	8.84	9.46	10.97	12.98
10	13.40	13.40	14.88	18.59
15	30.15	30.15	30.15	41.54
20	53.60	53.60	53.60	76.43
25	83.75	83.75	83.75	117.64
30	120.60	120.60	120.60	161.86
35	164.15	164.15	164.15	209.92
40	214.40	214.40	214.40	263.90
45	271.35	271.35	276.64	332.37

MINIMUM TURN RADIUS VS. REGEN. EFF.



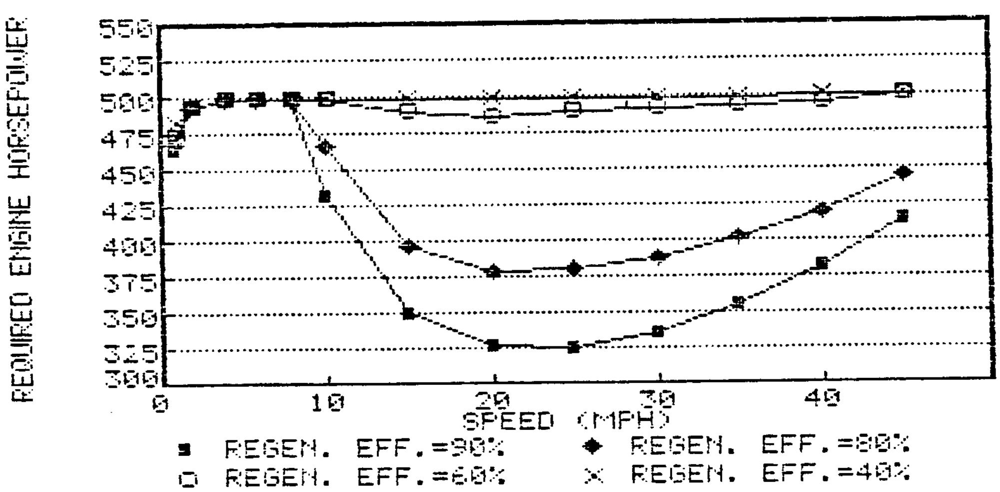
X Data	REGEN. EFF. = 90%	REGEN. EFF. = 80%	REGEN. EFF. = 60%	REGEN. EF
1	0.01	0.01	0.01	0.01
2	0.05	0.05	0.04	0.04
4	0.18	0.17	0.15	0.14
6	0.33	0.32	0.28	0.25
8	0.48	0.45	0.39	0.33
10	0.50	0.50	0.45	0.36
15	0.50	0.50	0.50	0.36
20	0.50	0.50	0.50	0.35
25	0.50	0.50	0.50	0.36
30	0.50	0.50	0.50	0.37
35	0.50	0.50	0.50	0.39
40	0.50	0.50	0.50	0.41
45	0.50	0.50	0.49	0.41

MAXIMUM LATERAL ACCELERATION



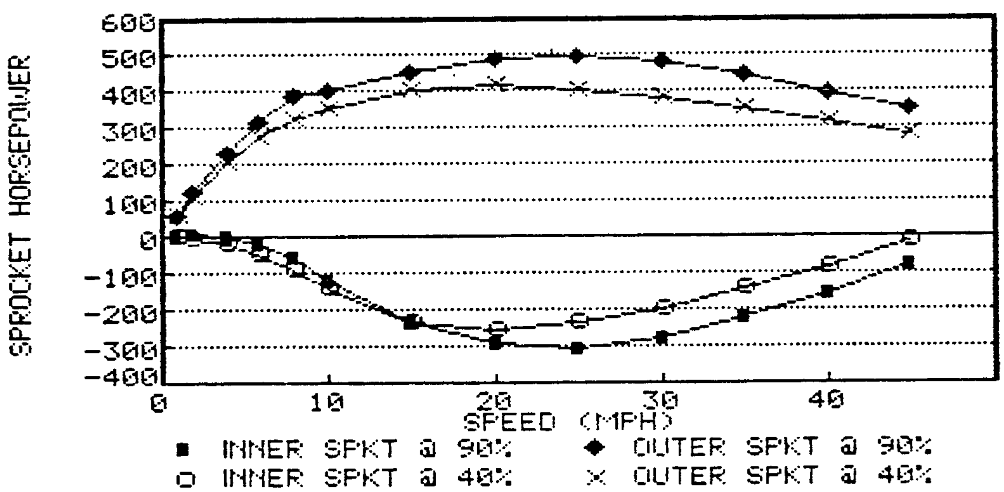
X Data	REGEN. EFF.=90%	REGEN. EFF.=80%	REGEN. EFF.=60%	REGEN. EFF.=40%
1	466	468	474	483
2	493	493	494	494
4	499	499	499	499
6	499	499	499	499
8	499	479	499	499
10	433	467	499	499
15	351	397	490	499
20	327	380	486	499
25	326	381	490	499
30	337	388	492	499
35	356	402	493	499
40	383	420	496	500
45	416	446	500	500

REQUIRED ENG. HP AT MAX. STEER CONDITION



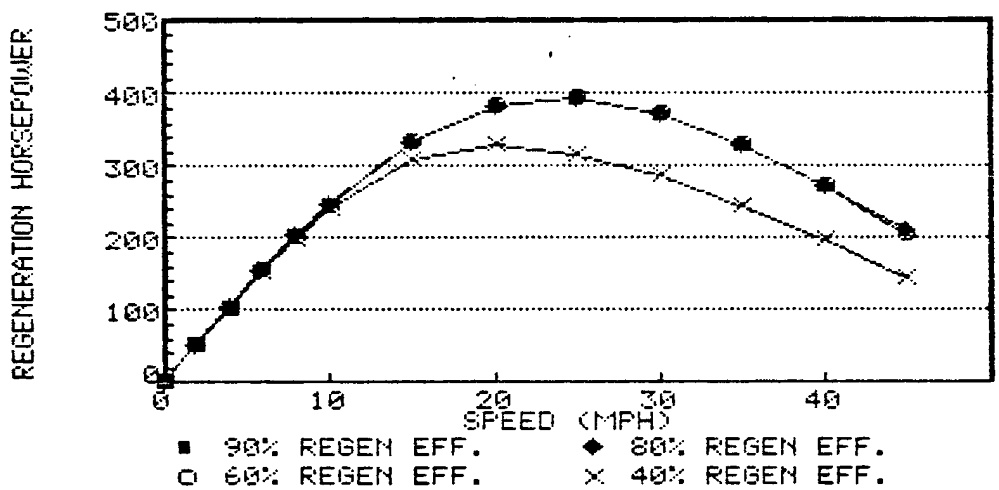
X Data	INNER SPKT @ 90%	OUTER SPKT @ 90%	INNER SPKT @ 40%	OUTER SPK
1	4.73	63.27	0.21	57.42
2	9.15	126.15	-1.94	111.72
4	4.43	234.40	-17.86	204.68
6	-16.57	320.93	-48.30	276.71
8	-51.80	387.11	-91.06	327.51
10	-116.86	404.26	-140.81	357.07
15	-232.50	452.45	-229.44	403.59
20	-290.43	488.21	-254	416
25	-301.40	497.20	-235.33	405.57
30	-274.45	480.19	-194.63	383.54
35	-220.37	444.44	-140.86	354.32
40	-150.54	399.49	-78.98	321.35
45	-75.10	354.42	-7.91	282.79

REGENERATION EFF. VS SPROCKET HP



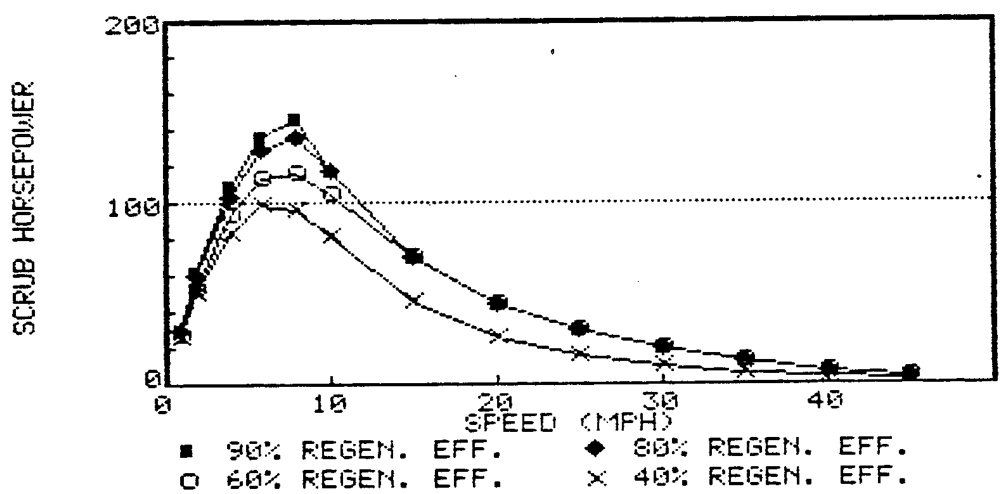
X Data	90% REGEN EFF.	80% REGEN EFF.	60% REGEN EFF.	40% REGEN EFF.
0	0	0	0	0
2	52	52	52	52
4	104	104	103	103
6	155	155	154	152
8	204	204	202	199
10	248	248	246	240
15	334	334	334	310
20	383	383	383	331
25	394	394	394	317
30	373	373	373	286
35	329	329	329	245
40	272	272	272	197
45	212	212	205	143

REGENERATION, EFF. VS HP

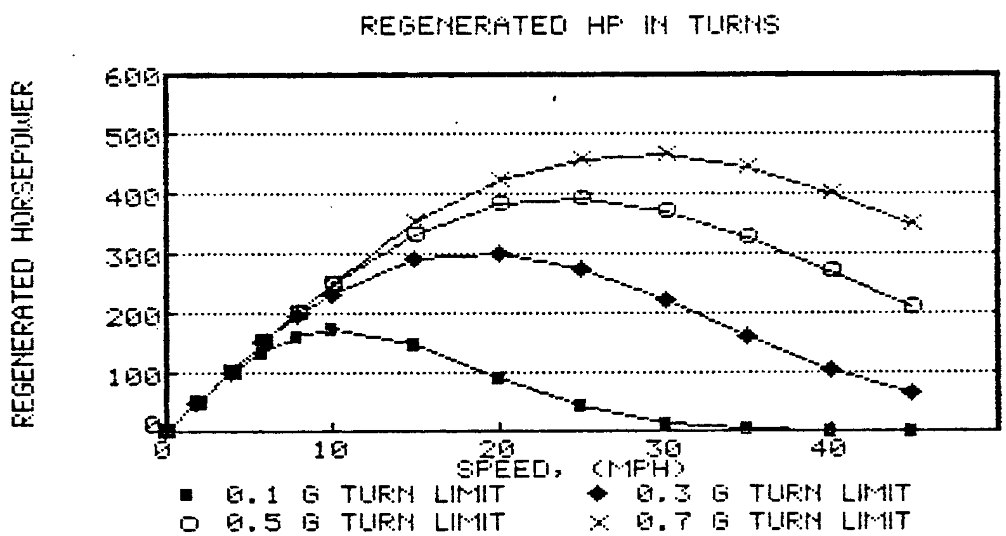


X Data	90% REGEN. EFF.	80% REGEN. EFF.	60% REGEN. EFF.	40% REGEN. E
1	31	30	28	26
2	62	60	54	50
4	109	103	93	83
6	137	129	114	99
8	147	137	117	97
10	118	118	105	82
15	70	70	70	47
20	45	45	45	27
25	30	30	30	17
30	20	20	20	11
35	13	13	13	7
40	8	8	8	5
45	5	5	5	3

SCRUB HP VS REGENERATION EFFICIENCY



X Data	0.1 G TURN LIMIT	0.3 G TURN LIMIT	0.5 G TURN LIMIT	0.7 G TUR
0	0	0	0	0
2	52	52	52	52
4	101	104	104	104
6	139	154	155	155
8	164	197	204	204
10	175	234	248	252
15	152	293	334	353
20	95	304	383	423
25	44	275	394	460
30	16	222	373	466
35	5	162	329	445
40	1	108	272	403
45	0	66	212	349



B.4 Impact Of Grades On Motor Loads While Steering

Data for turns on grades was evaluated and found to produce high momentary loads that are within the thermal limits of the drive components. Two curve sets were produced to investigate alternate operational assumptions.

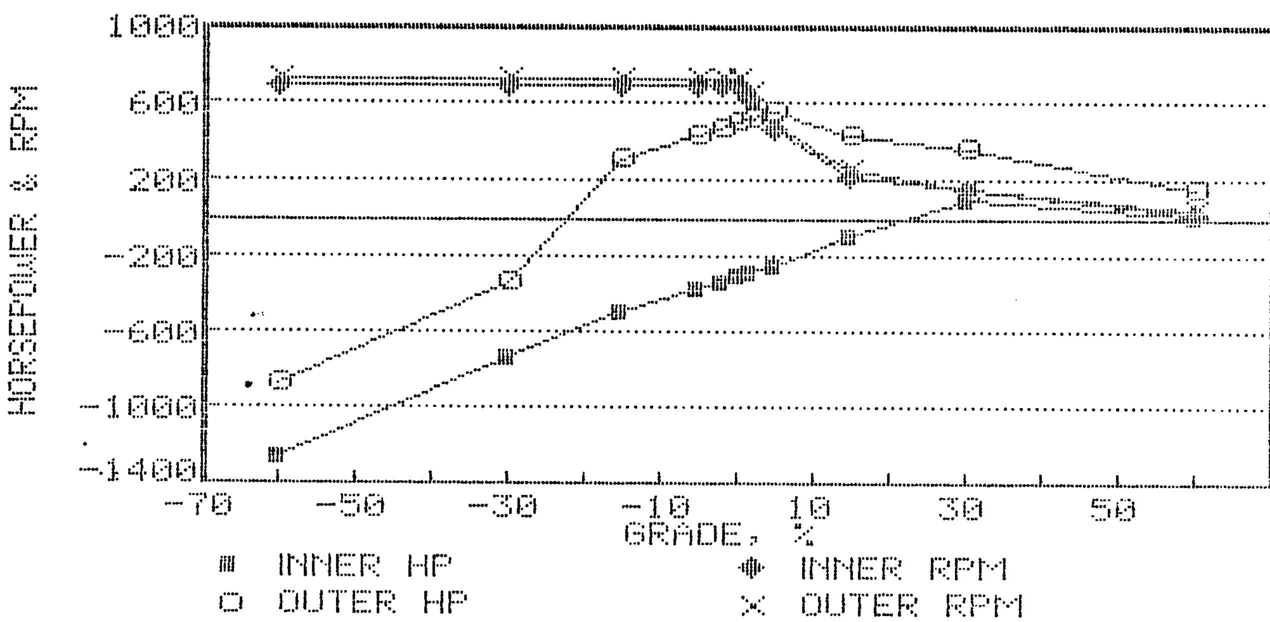
The first set (Figure B.4-1) are titled "Grade vs. Maximum Sprocket HP & RPM". These curves plot the speeds and loads for the highest horsepowers and RPM that are theoretically possible. The power inputs from the ground (indicated as horsepower) become very high under certain conditions. The implied operation that produced these results cover some areas that are unrealistic combinations of speed, grade and turn radius. It is considered unlikely that a driver will make the sharpest possible turn, at maximum speed on the steepest downgrade.

The second set of curves (Figure B.4-2) titled "Grade vs. Maximum Sprocket HP & RPM (LTD)" represent a more limited operational envelope. Downhill speeds are limited to the speeds that the vehicle can achieve on upgrades. These curves are considered representative of a prudent driver under normal operating conditions.

All points on the "LTD" curve are easily within the momentary overload capacity of the drives, which is considered reasonable for turning requirements. Downgrades steeper than 40% impose excessive loads at maximum 45 MPH speed, but operation at this combination of grade and speed is considered unrealistic. It was therefore concluded that normal turns on grades could present no peculiar load problems for the recommended electric drive systems.

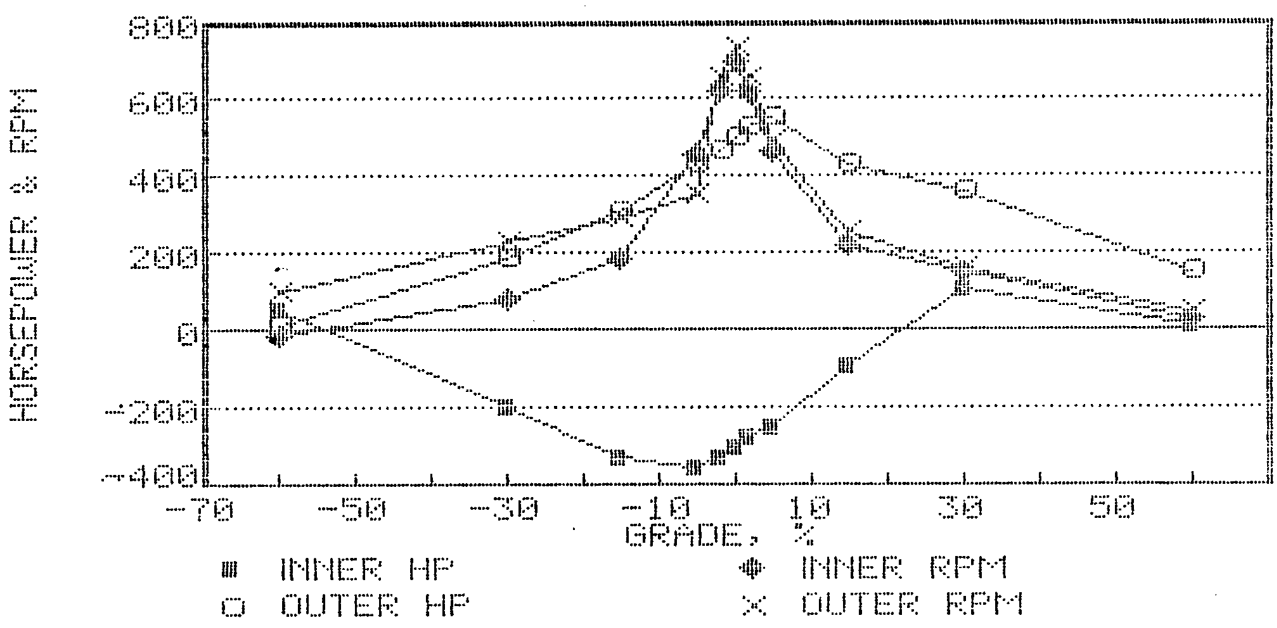
X Data	INNER HP	INNER RPM	OUTER HP	OUTER RPM
-60	-1250.89	699.67	-877.63	733.17
-30	-731	699.67	-333.68	733.17
-15	-493.71	699.67	315.70	733.17
-5	-361.42	699.67	430.15	733.17
-2	-325.45	699.67	469.25	733.17
0	-301.42	699.67	497.22	733.17
2	-277.40	617.97	525.18	655.66
5	-244.67	462.01	556.30	493.21
15	-93	223.28	430.98	254.34
30	111.69	154.84	361.74	163.57
60	16.49	32.89	148.84	46.71

GRADE VS MAXIMUM SPROCKET HP & RPM



X Data	INNER HP	INNER RPM	OUTER HP	OUTER RPM
-60	54.12	-17.08	13	96.68
-30	-195.50	83.83	184.11	234.58
-15	-323.88	188.55	312.41	289.06
-5	-348.27	452.49	430.15	356.10
-2	-325.45	617.97	469.25	655.66
0	-301.42	699.67	497.22	733.17
2	-277.40	617.97	525.18	655.66
5	-244.67	462.01	556.30	493.21
15	-93	223.28	430.98	254.34
30	111.69	154.84	361.74	163.57
60	16.49	32.89	148.84	46.71

GRADE VS MAX SPROCKET HP & RPM (LTD.)



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SPROCKET HORSEPOWER

CODE: #2TRTRN

BY: W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE: 52985.11

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-60
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.77	16.68	-5.27	-16624.15	4.86	37.11	687.73
2.50	0.09	4.44	54.12	-17.08	-16642.10	13.00	96.68	706.35
5.00	0.50	3.35	226.28	-71.16	-16702.05	33.72	230.36	768.70
7.50	0.50	7.54	-59.25	18.90	-16467.32	22.53	219.91	537.98
10.00	0.50	13.40	-257.74	83.83	-16149.08	10.07	234.58	225.35
15.00	0.50	30.15	-549.38	188.55	-15302.82	-33.29	289.06	-604.87
20.00	0.50	53.60	-762.19	280.72	-14260.26	-110.18	356.10	-1624.99
25.00	0.50	83.75	-919.60	367.86	-13129.57	-222.30	428.16	-2726.82
30.00	0.50	120.60	-1034.86	452.49	-12011.83	-364.63	502.74	-3809.30
35.00	0.50	164.15	-1120.58	535.68	-10986.82	-528.12	578.75	-4792.63
40.00	0.50	214.40	-1189.04	617.97	-10105.57	-702.31	655.66	-5625.78
45.00	0.50	271.35	-1250.89	699.67	-9389.87	-877.63	733.17	-6286.98

****

END

SPROCKET HORSEPOWER

CODE: #2TRTRN

BY: W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE: 52985.10

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-30
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.81	12.26	-5.06	-12724.82	32.19	36.90	4581.70
2.50	0.09	4.73	32.86	-13.56	-12729.08	81.36	93.16	4586.63
5.00	0.37	4.54	76.72	-31.63	-12738.60	167.09	190.83	4598.55
7.50	0.50	7.54	-45.23	18.90	-12570.67	185.68	219.91	4434.63
10.00	0.50	13.40	-195.55	83.83	-12252.43	184.11	234.58	4122.00
15.00	0.50	30.15	-409.49	188.55	-11406.18	181.17	289.06	3291.78
20.00	0.50	53.60	-553.92	280.72	-10363.61	154.02	356.10	2271.66
25.00	0.50	83.75	-646.68	367.86	-9232.92	95.37	428.16	1169.82
30.00	0.50	120.60	-699.15	452.49	-8115.18	8.36	502.74	87.35
35.00	0.50	164.15	-723.15	535.68	-7090.17	-98.73	578.75	-895.98
40.00	0.50	214.40	-730.55	617.97	-6208.92	-215.86	655.66	-1729.13
45.00	0.50	271.35	-731.79	699.67	-5493.22	-333.68	733.17	-2390.33

END

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.09

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-15
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.84	9.71	-4.93	-10338.55	48.76	36.77	6964.69
2.50	0.09	4.91	22.85	-11.61	-10334.45	120.90	91.21	6961.25
5.00	0.31	5.38	27.95	-14.24	-10307.07	229.06	173.44	6936.28
7.50	0.50	7.54	-36.65	18.90	-10186.04	285.53	219.91	6819.26
10.00	0.50	13.40	-157.49	83.83	-9867.80	290.62	234.58	6506.62
15.00	0.50	30.15	-323.88	188.55	-9021.55	312.41	289.06	5676.41
20.00	0.50	53.60	-426.47	280.72	-7978.98	315.70	356.10	4656.28
25.00	0.50	83.75	-479.66	367.86	-6848.29	289.77	428.16	3554.45
30.00	0.50	120.60	-493.71	452.49	-5730.56	236.62	502.74	2471.98
35.00	0.50	164.15	-479.93	535.68	-4705.54	164.04	578.75	1488.65
40.00	0.50	214.40	-449.97	617.97	-3824.30	81.83	655.66	655.49
45.00	0.50	271.35	-414.12	699.67	-3108.60	-0.80	733.17	-5.70

****

END

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.08

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 40
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-5
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.64	9.66	-5.85	-8661.95	62.19	37.70	8664.22
2.50	0.09	4.82	20.79	-12.62	-8651.65	151.97	92.22	8654.59
5.00	0.29	5.72	14.31	-8.74	-8600.39	275.18	167.94	8605.73
7.50	0.50	7.54	-30.58	18.90	-8497.97	356.21	219.91	8507.33
10.00	0.50	13.40	-130.55	83.83	-8179.73	366.01	234.58	8194.69
15.00	0.50	30.15	-263.28	188.55	-7333.48	405.32	289.06	7364.48
20.00	0.50	53.60	-336.24	280.72	-6290.91	430.15	356.10	6344.35
25.00	0.50	83.75	-361.42	367.86	-5160.23	427.38	428.16	5242.52
30.00	0.50	120.60	-348.27	452.49	-4042.49	398.21	502.74	4160.05
35.00	0.50	164.15	-307.76	535.68	-3017.48	350.06	578.75	3176.72
40.00	0.50	214.40	-251.35	617.97	-2136.23	292.57	655.66	2343.56
45.00	0.50	271.35	-189.24	699.67	-1420.53	234.85	733.17	1682.37

****

END

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.07

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 40
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-2
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.64	9.04	-5.83	-8147.97	65.82	37.67	9177.52
2.50	0.08	5.06	15.68	-10.14	-8124.66	156.42	89.74	9154.86
5.00	0.28	6.04	6.17	-4.02	-8068.87	282.85	163.22	9101.48
7.50	0.50	7.59	-29.69	19.53	-7981.70	376.51	219.27	9018.33
10.00	0.50	13.40	-122.35	83.83	-7666.09	388.95	234.58	8708.33
15.00	0.50	30.15	-244.84	188.55	-6819.84	433.59	289.06	7878.11
20.00	0.50	53.60	-308.79	280.72	-5777.27	464.98	356.10	6857.99
25.00	0.50	83.75	-325.45	367.86	-4646.59	469.25	428.16	5756.16
30.00	0.50	120.60	-304.02	452.49	-3528.85	447.37	502.74	4673.69
35.00	0.50	164.15	-255.37	535.68	-2503.84	406.66	578.75	3690.36
40.00	0.50	214.40	-190.92	617.97	-1622.59	356.69	655.66	2857.20
45.00	0.50	271.35	-120.81	699.67	-906.89	306.55	733.17	2196.01

END

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.06

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 40
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%= 0
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	5.02	6.23	-4.21	-7784.08	65.20	36.05	9499.67
2.50	0.08	5.20	12.94	-8.74	-7773.54	159.62	88.34	9489.80
5.00	0.27	6.25	1.69	-1.15	-7713.93	287.99	160.35	9432.63
7.50	0.47	7.95	-34.97	24.11	-7618.74	381.86	214.70	9341.42
10.00	0.50	13.40	-116.88	83.83	-7323.07	404.27	234.58	9051.36
15.00	0.50	30.15	-232.52	188.55	-6476.82	452.46	289.06	8221.14
20.00	0.50	53.60	-290.45	280.72	-5434.25	488.24	356.10	7201.02
25.00	0.50	83.75	-301.42	367.86	-4303.56	497.22	428.16	6099.18
30.00	0.50	120.60	-274.47	452.49	-3185.82	480.21	502.74	5016.71
35.00	0.50	164.15	-220.39	535.68	-2160.81	444.45	578.75	4033.38
40.00	0.50	214.40	-150.56	617.97	-1279.56	399.51	655.66	3200.23
45.00	0.50	271.35	-75.12	699.67	-563.86	354.44	733.17	2539.03

****

END

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.04

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ;mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%= 2
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	5.44	3.73	-2.64	-7417.55	64.47	34.48	9819.20
2.50	0.07	5.62	7.22	-5.12	-7407.22	158.24	84.72	9809.54
5.00	0.24	6.86	-8.42	6.03	-7337.28	284.13	153.18	9742.01
7.50	0.43	8.81	-45.96	33.39	-7228.92	376.93	205.41	9637.65
10.00	0.50	13.40	-111.40	83.83	-6980.04	419.60	234.58	9394.38
15.00	0.50	30.15	-220.21	188.55	-6133.79	471.34	289.06	8564.16
20.00	0.50	53.60	-272.12	280.72	-5091.22	511.49	356.10	7544.04
25.00	0.50	83.75	-277.40	367.86	-3960.54	525.18	428.16	6442.21
30.00	0.50	120.60	-244.92	452.49	-2842.80	513.04	502.74	5359.74
35.00	0.50	164.15	-185.40	535.68	-1817.79	482.25	578.75	4376.41
40.00	0.50	214.40	-110.19	617.97	-936.54	442.33	655.66	3543.25

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.03

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%= 5
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	5.68	2.45	-1.87	-6890.78	66.24	33.71	10319.70
2.50	0.07	5.98	3.20	-2.45	-6873.85	160.96	82.05	10303.44
5.00	0.23	7.30	-13.55	10.47	-6799.41	289.75	148.74	10231.41
7.50	0.39	9.55	-50.98	40.12	-6674.76	382.50	198.69	10110.77
10.00	0.49	13.60	-104.38	84.92	-6456.02	440.02	233.49	9897.64
15.00	0.50	30.15	-201.77	188.55	-5620.15	499.61	289.06	9077.80
20.00	0.50	53.60	-244.67	280.72	-4577.59	546.32	356.10	8057.68
25.00	0.48	87.16	-234.25	369.04	-3333.84	556.30	426.98	6842.79
30.00	0.31	194.25	-68.50	462.01	-778.65	405.95	493.21	4322.86

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.01

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%= 15
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	6.47	-0.30	0.31	-5158.84	71.83	31.53	11963.90
2.50	0.06	7.27	-4.94	5.08	-5114.34	169.14	74.52	11920.07
5.00	0.18	9.35	-24.38	25.61	-4999.53	300.33	133.59	11807.67
7.50	0.28	13.37	-57.12	62.72	-4782.95	388.74	176.08	11595.10
10.00	0.29	22.75	-93.98	114.80	-4299.46	430.98	203.61	11117.22
15.00	0.15	97.57	-57.01	223.28	-1341.11	395.87	254.34	8174.90

SPROCKET HORSEPOWER

CODE: #2TRTRN

BY: W.E. RODLER
L.M. FERNANDEZ

REV. DATE: 91984
RUN DATE: 52985.02

****

DATA INPUT:

GROSS VEHICLE WEIGHT, tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH, in= 92.5
TRACK LENGTH, in= 150
TRACK PITCH, in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE, lb per ton= 100

GRADE, %= 30
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	9.23	-2.49	4.98	-2623.10	72.61	26.86	14197.42
2.50	0.04	10.34	-7.51	15.38	-2562.79	172.87	64.22	14137.78
5.00	0.11	15.38	-20.43	46.77	-2294.58	296.97	112.44	13871.97
7.50	0.12	30.10	-28.00	94.24	-1560.50	361.74	144.57	13141.90
10.00	0.03	231.58	111.69	154.84	3788.48	242.87	163.57	7798.54

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:52985.05

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.5
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%= 60
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.00	21.05	4.00	11.12	1890.67	68.94	20.72	17476.94
2.50	0.01	36.55	16.49	32.89	2632.33	148.84	46.71	16735.96

B.5 Downhill Steering Limit

Limited available power while coasting downhill can limit steering control. When operating on moderate downgrades, the engine can at times be operating near idle condition. Steering reactions can then be limited by power available. This condition is encountered with mechanically driven tracked vehicles and it is necessary for the drive to give the engine added throttle to obtain normal steering response. Since it is instinctive to turn and apply brakes to avoid an obstacle, special driver training is required to assure proper response. The results of the studies on this subject are shown on the following curves and their data sheets.

1. Figure B.5-1: These curves show a typical power distribution for maximum turn going down a moderate grade.

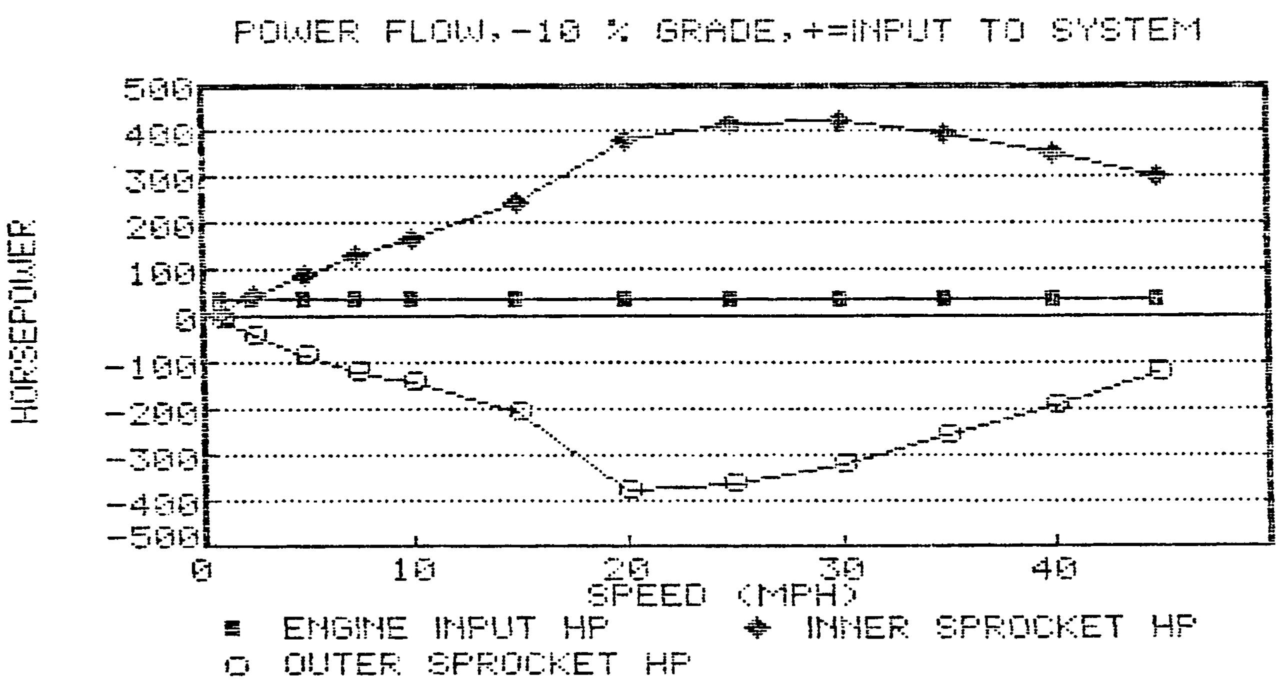
2. Figure B.5-2: These curves replot the same data as Figure B.5-1, but a summation curve "Engine + Both Sprockets" is shown. At points near 20 MPH the net power barely covers system losses.

3. Figure B.5-3: These curves show that below 20 MPH decreased net engine power degrades steering ability.

4. Figure B.5-4 and B.5-5: These curves plot the same data with different scales for better legibility. They show that steering ability is limited up to 25 MPH.

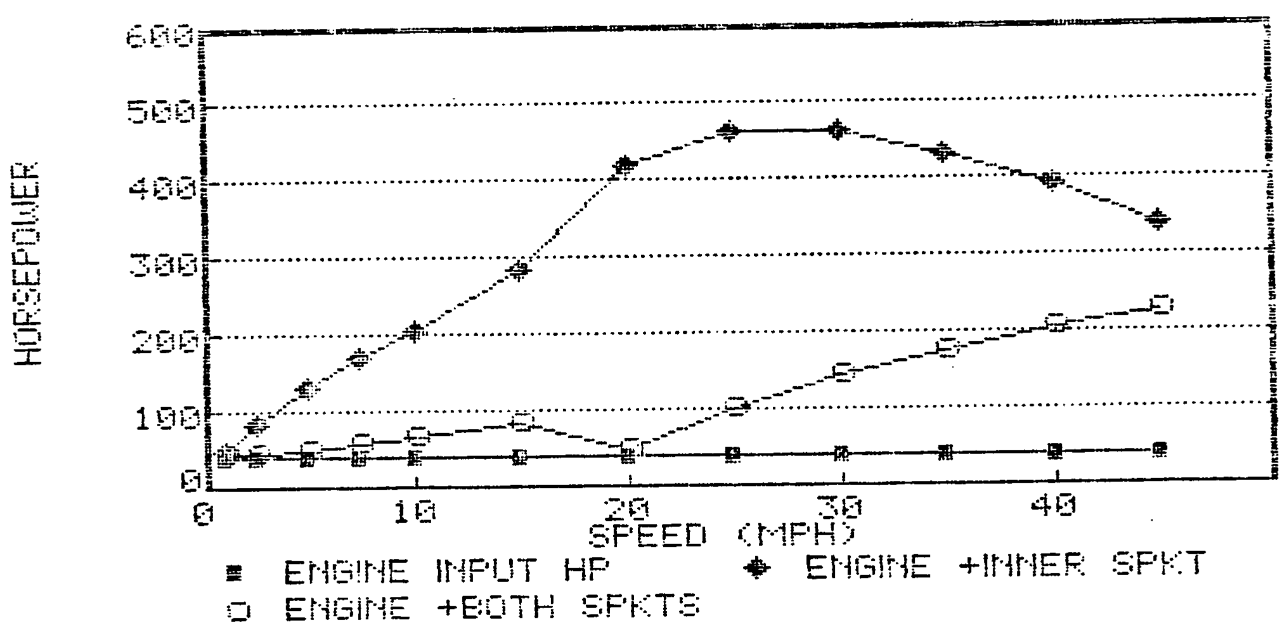
Acceleration analysis was made for the 60% grade starts and the results are shown in Figures 5.2.6.4-1. These curves show positive starts that promptly reach grade limited speed.

X Data	ENGINE INPUT HP	INNER SPROCKET HP	OUTER SPROCKET HP
1	40	9.94	-5.29
2.50	40	46.46	-42.85
5	40	92	-83.80
7.50	40	132.80	-116.02
10	40	167.29	-138.97
15	40	245.55	-201.24
20	40	381.67	-372.48
25	40	420.95	-355.04
30	40	421.51	-316.79
35	40	394.47	-256.34
40	40	351.38	-186.40
45	40	302.50	-116.14

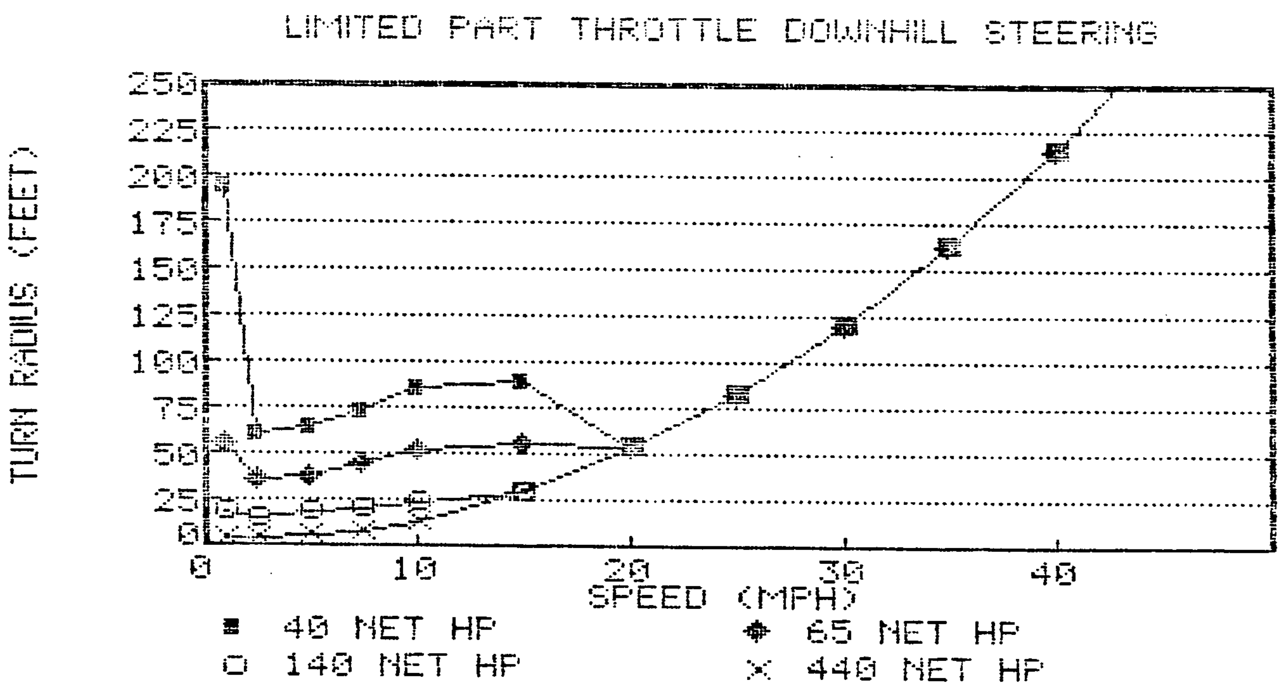


X Data	ENGINE INPUT HP	ENGINE +INNER SPKT	ENGINE +BOTH SPKTS
1	40	9.94	-5.29
2.50	40	46.46	-42.85
5	40	92	-83.80
7.50	40	132.80	-116.02
10	40	167.29	-138.97
15	40	245.55	-201.24
20	40	381.67	-372.48
25	40	420.95	-358.04
30	40	421.51	-316.79
35	40	394.47	-256.34
40	40	351.38	-186.40
45	40	302.50	-116.14

POWER FLOW, -10 % GRADE, +=INPUT TO SYSTEM

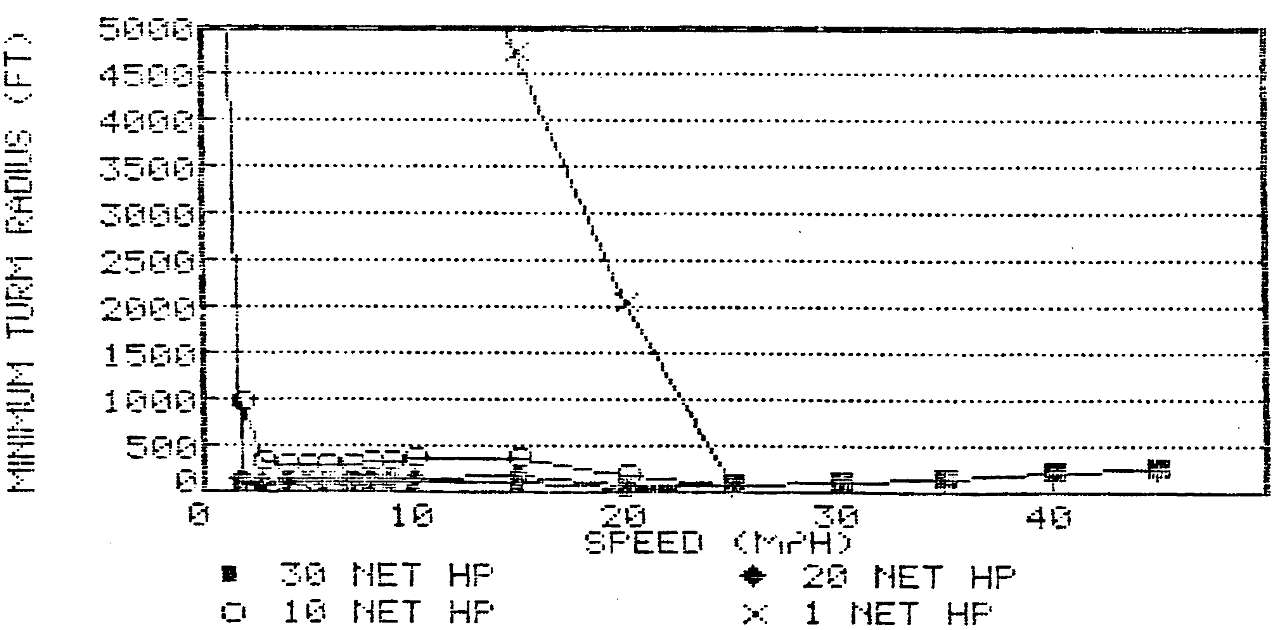


X Data	40 NET HP	65 NET HP	140 NET HP	440 NET HP
1	194.88	56.54	18.07	4.85
2.50	62.12	36.16	16.04	4.97
5	64.65	39.02	17.97	5.68
7.50	73.82	45.09	20.80	7.54
10	86.38	52.89	24.45	13.40
15	90.75	55.72	30.15	30.15
20	53.60	53.60	53.60	53.60
25	83.75	83.75	83.75	83.75
30	120.60	120.60	120.60	120.60
35	164.15	164.15	164.15	164.15
40	214.40	214.40	214.40	214.40
45	271.35	271.35	271.35	271.35



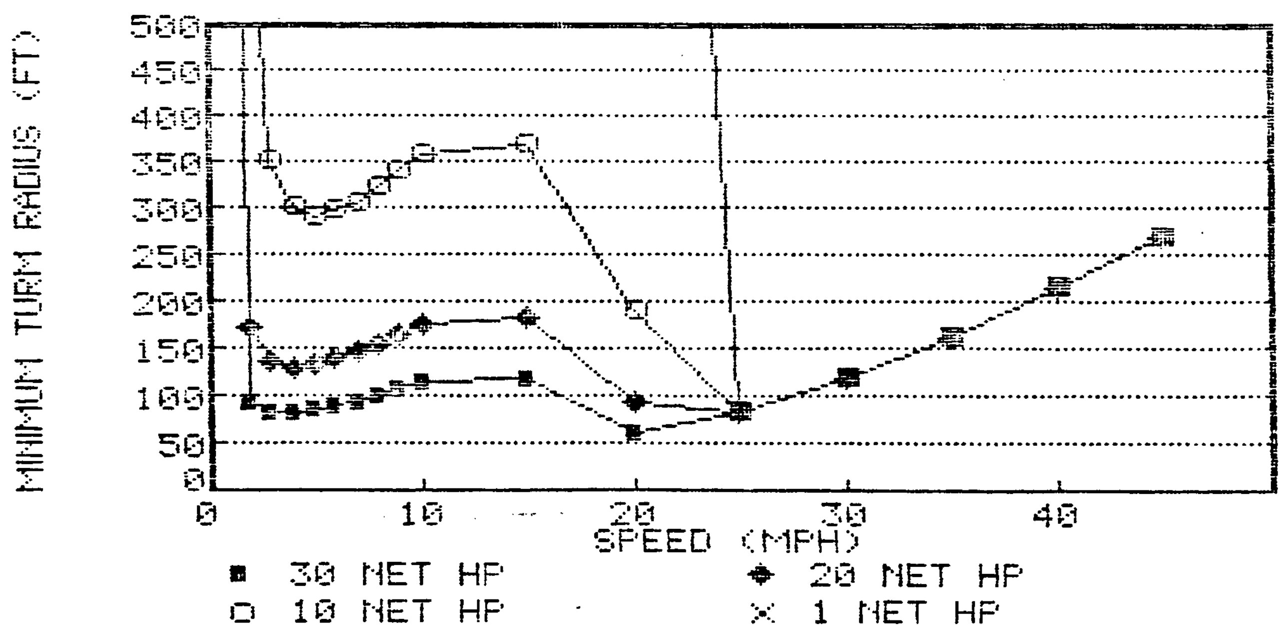
X Data	30 NET HP	20 NET HP	10 NET HP	1 NET HP
1	9108.08			
2	95.08	173.44	986.73	
3	84.55	136.40	352.76	
4	84.59	132.11	301.45	
5	87.33	134.50	292.54	
6	91.34	139.66	296.52	
7	96.28	146.57	306.86	19534.49
8	102.11	155.01	321.68	9943.98
9	108.97	165.11	340.61	7847.88
10	115.67	175.01	359.44	6962.97
15	121.24	182.60	369.69	4746.54
20	63.59	95.49	191.67	2048.84
25	83.75	83.75	83.75	83.75
30	120.60	120.60	120.60	120.60
35	164.15	164.15	164.15	164.15
40	214.40	214.40	214.40	214.40
45	271.35	271.35	271.35	271.35

PART THROTTLE DOWNHILL STEERING LIMITS



X Data	30 NET HP	20 NET HP	10 NET HP	1 NET HP
1	9108.08			
2	95.08	173.44	986.73	
3	84.55	136.40	352.76	
4	84.59	132.11	301.45	
5	87.33	134.50	292.54	
6	91.34	139.66	296.52	
7	96.28	146.57	306.86	19534.49
8	102.11	155.01	321.68	9943.98
9	108.97	165.11	340.61	7847.88
10	115.67	175.01	359.44	6962.97
15	121.24	182.60	369.69	4746.54
20	63.59	95.49	191.67	2048.84
25	83.75	83.75	83.75	83.75
30	120.60	120.60	120.60	120.60
35	164.15	164.15	164.15	164.15
40	214.40	214.40	214.40	214.40
45	271.35	271.35	271.35	271.35

PART THROTTLE DOWNHILL STEERING LIMITS



SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.01

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 125
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.00	56.54	-18.97	14.13	-7047.65	18.03	17.71	5349.33
	0.01	36.16	-49.47	32.82	-7918.06	55.41	46.79	6220.42
	0.04	39.20	-98.82	66.72	-7779.53	107.14	92.49	6084.30
7.50	0.08	45.09	-146.89	102.60	-7519.33	151.14	136.21	5828.10
10.00	0.13	52.89	-191.77	140.11	-7188.98	186.83	178.30	5503.36
15.00	0.27	55.72	-284.71	211.61	-7066.44	273.33	266.00	5396.85
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.46	535.68	-3867.58	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99

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SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.02

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DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 100
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

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**************************************************************************************************
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RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.00	194.88	-9.94	15.40	-3389.41	5.29	16.44	1691.09
2.50	0.01	62.12	-46.46	35.74	-6828.45	42.85	43.87	5130.81
[illegible]	0.03	64.65	-92.00	71.79	-6730.42	83.80	87.41	5035.19
[illegible]	0.05	73.82	-132.80	109.14	-6390.59	116.02	129.67	4699.36
10.00	0.08	86.38	-167.29	147.51	-5956.53	138.97	170.90	4270.91
15.00	0.17	90.75	-245.55	222.11	-5806.35	201.24	255.50	4136.77
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	[illegible].50	271.35	-302.50	699.67	-2270[illegible]	116.14	733.17	831.99

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.04

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 90
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.00	9108.08	-2.57	15.91	-849.16	-2.58	15.93	-849.16
2.50	0.00	87.14	-41.72	36.90	-5937.38	34.47	42.70	4239.74
	0.02	87.33	-83.35	73.82	-5930.15	68.85	85.39	4234.92
	0.04	99.08	-118.25	111.76	-5557.25	93.52	127.05	3866.02
10.00	0.06	115.67	-145.44	150.47	-5076.39	108.42	167.94	3390.78
15.00	0.12	121.24	-211.95	226.31	-4918.88	155.47	251.30	3249.30
20.00	0.42	63.59	-368.21	286.63	-6746.88	340.02	350.18	5099.74
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.05

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 200
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.00	18.07	-17.29	10.33	-8793.15	29.06	21.51	7094.84
2.50	0.03	16.04	-40.76	24.06	-8897.13	76.13	55.54	7199.49
	0.09	17.97	-86.26	51.50	-8796.37	145.62	107.70	7101.13
	0.18	20.80	-136.68	82.98	-8650.86	206.49	155.83	6959.63
10.00	0.27	24.45	-190.04	117.89	-8466.32	258.87	200.51	6780.71
15.00	0.50	30.15	-293.78	188.55	-8183.34	358.50	289.06	6513.76
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	0.50	271.35	-302.50	699.67	-227[illegible]	116.14	733.17	831.99

****

SPROCKET HORSEPOWER

CODE:#2TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.06

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 300
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	9.47	-9.25	5.26	-9245.86	38.20	26.58	7547.54
2.50	0.05	9.21	-21.84	12.39	-9259.66	96.78	67.22	7562.02
	0.16	10.44	-54.63	31.22	-9192.19	182.69	127.99	7496.96
	0.31	12.11	-98.46	56.82	-9100.97	256.75	181.99	7409.74
10.00	0.47	14.24	-151.03	88.28	-8985.17	319.84	230.13	7299.55
15.00	0.50	30.15	-293.78	188.55	-8183.34	358.50	289.06	6513.76
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99

CODE:#2TRTRN

SPROCKET HORSEPOWER

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.07

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 400
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	6.42	-0.33	0.18	-9412.88	46.50	31.66	7714.52
2.50	0.06	6.46	-1.28	0.71	-9410.20	115.85	78.89	7712.57
	0.23	7.35	-19.48	10.93	-9359.79	216.38	148.27	7664.55
	0.44	8.54	-54.25	30.66	-9293.14	301.27	208.15	7601.92
10.00	0.50	13.40	-144.10	83.82	-9029.54	328.02	234.59	7343.92
15.00	0.50	30.15	-293.78	188.55	-8183.34	358.50	289.06	6513.76
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	[illegible].50	271.35	-302.50	699.67	-2270[illegible]	116.14	733.17	831.99

CODE:#2TRTRN

SPROCKET HORSEPOWER

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE: 91984
RUN DATE:60385.08

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 500
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
1.00	0.01	4.85	8.84	-4.89	-9499.69	54.56	36.73	7801.38
2.50	0.08	4.97	19.81	-10.96	-9492.64	134.41	90.56	7795.00
5.00	0.29	5.68	16.84	-9.36	-9452.36	248.96	168.56	7757.12
[illegible]	0.50	7.54	-33.62	18.89	-9347.76	320.59	219.92	7656.54
[illegible]	0.50	13.40	-144.10	83.82	-9029.54	328.02	234.59	7343.92
15.00	0.50	30.15	-293.78	188.55	-8183.34	358.50	289.06	6513.76
20.00	0.50	53.60	-381.67	280.72	-7140.83	372.48	356.10	5493.69
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
35.00	0.50	164.15	-394.46	535.68	-3867.58	256.34	578.75	2326.25
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99

END

****

SPROCKET HORSEPOWER

CODE:#3TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE:6/3/85
RUN DATE:60385.10

****

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 90
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

****

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
20.00	0.42	63.59	-368.21	286.63	-6746.88	340.02	350.10	5099.74
15.00	0.12	121.24	-211.95	226.31	-4918.88	155.47	251.30	3249.30
10.00	0.06	115.67	-145.44	150.47	-5076.39	108.42	167.94	3390.70
9.00	0.05	108.97	-135.26	134.94	-5264.50	103.25	151.63	3576.45
8.00	0.04	102.11	-124.30	119.45	-5465.50	97.24	135.28	3775.27
7.00	0.03	96.28	-111.86	104.10	-5643.54	89.37	118.79	3951.39
6.00	0.03	91.34	-98.15	88.89	-5799.63	79.86	102.16	4105.80
5.00	0.02	87.33	-83.35	73.82	-5930.15	68.85	85.39	4234.92
4.00	0.01	84.59	-67.53	58.91	-6021.08	56.37	68.46	4324.69
3.00	0.01	84.55	-50.66	44.18	-6023.07	42.29	51.35	4325.78
2.00	0.00	95.08	-32.16	29.72	-5683.72	25.78	33.97	3985.79
1.00	0.00	9108.08	-2.57	15.91	-849.16	-2.58	15.93	-849.16

****

END

SPROCKET HORSEPOWER

CODE:#3TRTRN

BY:W.E. RODLER
L.M. FERNANDEZ

REV.DATE:6/3/85
RUN DATE:60385.11

DATA INPUT:

GROSS VEHICLE WEIGHT,tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 80
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH,in= 92.51999
TRACK LENGTH,in= 150
TRACK PITCH,in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE,lb per ton= 100

GRADE,%=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	735.17	831.99
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
35.00	0.50	164.15	-394.47	535.68	-3867.59	256.34	578.75	2326.25
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
25.00	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
20.00	0.28	95.49	-319.51	297.25	-5645.37	258.50	339.56	3998.23
15.00	0.08	182.60	-157.31	230.51	-3584.35	90.09	247.10	1914.77
10.00	0.04	175.01	-108.97	153.43	-3730.19	64.22	164.98	2044.57
9.00	0.03	165.11	-102.88	137.78	-3921.77	63.28	148.79	2233.72
8.00	0.03	155.01	-96.05	122.15	-4129.99	61.59	132.58	2439.76
7.00	0.02	146.57	-87.59	106.62	-4314.79	58.06	116.27	2622.63
6.00	0.02	139.66	-77.67	91.18	-4473.73	52.86	99.86	2779.91
5.00	0.01	134.50	-66.39	75.85	-4597.03	46.06	83.36	2901.80
4.00	0.01	132.11	-53.74	60.62	-4655.81	37.61	66.74	2959.42
3.00	0.00	136.40	-39.47	45.54	-4552.39	27.17	49.98	2855.10
2.00	0.00	173.44	-21.99	30.68	-3765.81	13.00	33.01	2067.88

SPROCKET HORSE OWER

CODE: #3TRTRN

BY: W.E. RODLER
L.M. FERNANDEZ

REV. DATE: 6/3/85
RUN DATE: 60385.13

DATA INPUT:

GROSS VEHICLE WEIGHT, tons= 19.5
MAXIMUM VELOCITY ,mph= 45
ENGINE GROSS HP= 61
LOSS ENGINE HP= 60
FRONTAL AREA ,in= 57
COEFFICIENT OF DRAG= 1

TREAD WIDTH, in= 92.51999
TRACK LENGTH, in= 150
TRACK PITCH, in= 6.03
NUMBER OF SPROCKET TEETH= 11
ROLLING RESISTANCE, lb per ton= 100

GRADE, %=-10
COEFFICIENT OF FRICTION= .7
MAXIMUM ACCELERATION ,gs= .5
DRIVE EFF. @SR>.2= 82
REGENERATION EFF.= 90

RESULTS:

VEHICLE SPEED (mph)	LATERAL ACCELERATION (gs)	TURN RADIUS (ft)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET ROT. SPEED (rpm)	INNER SPROCKET TORQUE (lbft)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET ROT. SPEED (rpm)	OUTER SPROCKET TORQUE (lbft)
45.00	0.50	271.35	-302.50	699.67	-2270.73	116.14	733.17	831.99
40.00	0.50	214.40	-351.38	617.97	-2986.39	186.40	655.66	1493.14
35.00	0.50	164.15	-394.46	535.68	-3867.58	256.34	578.75	2326.25
30.00	0.50	120.60	-421.51	452.48	-4892.54	316.79	502.74	3309.52
)0	0.50	83.75	-420.95	367.86	-6010.21	358.04	428.16	4391.93
)0	0.01	2048.82	-49.78	317.42	-823.59	-50.08	319.39	-823.55
15.00	0.00	4746.54	-37.91	238.49	-834.79	-38.01	239.13	-834.79
10.00	0.00	6962.97	-25.52	159.06	-842.81	-25.57	159.35	-842.81
9.00	0.00	7847.88	-23.01	143.17	-844.03	-23.04	143.40	-844.03
8.00	0.00	9943.98	-20.48	127.28	-845.12	-20.51	127.44	-845.12
7.00	0.00	19534.49	-17.95	111.41	-846.08	-17.96	111.48	-846.08

B.6 A-C Induction Motor Drive System Electrical States

A detailed analysis of the oeprating states of all components was made to assure that all components were operating within normal rated limits. The results are given in the following tables:

1. 19.5 Ton, Configuration I
2. 19.5 Ton, Configuration II
3. 40.0 Ton, Configuration I
4. 40.0 Ton, Configuration II

The voltage, current and frequencies values have been given vs. vehicle speed to illustrate the operational characteristics. These tables confirmed that there were no peculiar operating points to cause failure of the components.

INDUCTION MOTOR CONFIGURATION 1, GVW= 19.5 ELECTRICAL STATE DATA

(DURING MAXIMUM TRACTIVE EFFORT CONDITION)

SPEED	ALTERNATOR					BRIDGES (EACH)		MOTORS(EACH)		
MPH	EXCITER		OUTPUT			INPUT		INPUT		
	"E"	"I"	"E"	"I"	"F"	"E"	"I"	"E"	"I"	"F"
1.5			515	410	250	510	205	82	1253	17
3.0				524	350		262	120	1092	33
4.5				524	500		262	142	924	50
6.0				526			263	161	817	67
7.5				528			264	179	738	83
9.0				530			265	195	681	100
10.5				536			268	210	639	117
12.0								224	600	133
13.5								237	566	150
15.0								249	539	166
16.5								261	515	183
18.0								271	495	200
19.5								282	476	216
21.0								293	458	233
22.5								303	442	250
24.0								314	426	266
25.5								323	415	283
27.0								332	404	300
28.5								341	393	317
30.0								350	383	333
31.5								358	373	350
33.0								367	365	367
34.5								376	357	384
36.0								384	349	400
37.5								392	342	417
39.0								400	335	433
40.5								408	329	450
42.0								417	322	466
43.5								424	316	483
45.0			515	536	500	510	268	432	310	500

INDUCTION MOTOR CONFIGURATION 1, GVW= 40T, ELECTRICAL STATE DATA

(DURING MAXIMUM TRACTIVE EFFORT CONDITION)

SPEED	ALTERNATOR					BRIDGES (EACH)		MOTORS(EACH)		
MPH	EXCITER		OUTPUT			INPUT		INPUT		
	"E"	"I"	"E"	"I"	"F"	"E"	"I"	"E"	"I"	"F"
1.5			412	1148	250	408	574	149	1471	13
3.0				1372	350		686	217	1266	27
4.5				1364	500		682	255	1071	40
6.0				1400			700	296	946	53
7.5				1398			699	327	856	67
9.0				1414			704	357	789	80
10.5			412	1420		408	710	385	738	93
12.0			616	942		612	471	409	692	106
13.5								433	654	120
15.0								455	622	133
16.5								476	595	146
18.0								496	571	160
19.5								516	549	173
21.0								535	529	186
22.5			616	942		612	471	556	510	200
24.0			718	808		714	404	573	494	213
25.5								590	480	227
27.0								608	466	240
28.5								625	453	253
30.0								642	441	267
31.5			718	808		714	404	657	431	270
33.0			820	708		816	354	673	421	293
34.5								689	411	306
36.0								703	403	320
37.5								719	394	333
39.0								734	386	346
40.5								747	379	360
42.0								762	372	373
43.5								776	365	386
45.0			820	708	500	816	354	791	358	400

INDUCTION MOTOR CONFIGURATION II, GVW= 19.5, ELECTRICAL STATE DATA

(DURING MAXIMUM TRACTIVE EFFORT CONDITION)

SPEED MPH	ALTERNATOR EXCITER "E"	ALTERNATOR EXCITER "I"	ALTERNATOR OUTPUT "E"	ALTERNATOR OUTPUT "I"	ALTERNATOR OUTPUT "F"	BRIDGE ~~(EACH)~~ INPUT "E"	BRIDGE ~~(EACH)~~ INPUT "I"	MOTOR ~~(EACH)~~ INPUT "E"	MOTOR ~~(EACH)~~ INPUT "I"	MOTOR ~~(EACH)~~ INPUT "F"
1.5			169	1253	250	166	1253	162	1253	17
3.0			249		350	246		240	1092	33
4.5			291.		500	288		284	924	50
6.0			329			326		322	817	67
7.5			365			362		358	738	83
9.0			397			394		390	681	100
10.5			427			424		420	639	117
12.0			455			452		448	600	133
13.5			481			478		474	566	150
15.0			505			502		498	539	166
16.5			529			526		522	515	183
18.0			268			265		261	1030	200
19.5			290			287		283	950	216
21.0			311			308		304	882	233
22.5			333			330		326	824	250
24.0			355			352		348	772	266
25.5			376			373		369	727	283
27.0			398			395		391	686	300
28.5			420			417		413	650	317
30.0			442			439		435	618	333
31.5			463			460		456	588	350
33.0			485			482		478	561	367
34.5			507			504		500	537	384
36.0			529			526		522	515	400
37.5			550			547		543	494	417
39.0			572			569		565	475	433
40.5			594			591		587	457	450
42.0			616			613		609	441	466
43.5			637			634		630	426	483
45.0			659	412	500	656	412	652	412	500

INDUCTION MOTOR CONFIGURATION II, GVW= 40T, ELECTRICAL STATE DATA

(DURING MAXIMUM TRACTIVE EFFORT CONDITION)

SPEED	ALTERNATOR					BRIDGES		MOTORS		
MPH	EXCITER		OUTPUT			INPUT		INPUT		
	"E"	"I"	"E"	"I"	"F"	"E"	"I"	"E"	"I"	"F"
1.5			305	1471	250	302	1471	298	1471	13
3.0			441		350	438		434	1266	27
4.5			517		500	514		510	1071	40
6.0			599			596		592	946	53
7.5			661			658		654	856	67
9.0			721			718		714	789	80
10.5			777			774		770	738	93
12.0			416			413		409	1384	106
13.5			410			407		433	1308	120
15.0			462			459		455	1244	133
16.5			483			480		476	1190	146
18.0			503			500		496	1142	160
19.5			523			520		516	1098	173
21.0			542			539		535	1058	186
22.5			563			560		556	1020	200
24.0			600			577		573	988	213
25.5			597			594		590	960	227
27.0			615			612		608	932	240
28.5			632			629		625	906	253
30.0			649			646		642	882	267
31.5			664			661		657	862	270
33.0			670			667		673	842	293
34.5			696			693		689	822	306
36.0			710			707		703	806	320
37.5			726			723		719	788	333
39.0			740			737		734	772	346
40.5			754			751		747	758	360
42.0			769			766		762	744	373
43.5			783			780		776	730	386
45.0			798	358	500	795	358	791	358	400

B.7 Homopolar Motor Drive System Electrical States

A detailed analysis of the operating states of all components was made to assure that they were operating within normal rated limits. The results are given in the following tables:

1. 19.5 Ton, Configuration I

2. 40.0 Ton, Configuration I

The voltage and current values have been given tabulated vs. vehicle speed to illustrate the operational characteristics. These tables confirmed that there were no peculiar operating points to cause failure of the components.

ELECTRIC VEHICLE MISSION SIMULATION

DC HOMOPOLAR MOTOR DRIVE System
19.5 TON

FMC / NORTHERN ORDNANCE DIVISION
MINNEAPOLIS, MINNESOTA USA

REVISION DATE: 06/05/85
RUN DATE: 08-22-1985

ELECTRICALLY DRIVEN, TRACKED VEHICLE PERFORMANCE IS SIMULATED BY THIS PROGRAM. DETAILED ASPECTS OF VEHICLE PERFORMANCE CAN BE INVESTIGATED USING THE FOUR RESIDENT SUB-PROGRAMS LISTED BELOW. THE SUB-PROGRAM IN USE IS IDENTIFIED WITH AN ASTERISK.

* 1.) ELECTRIC DRIVE PERFORMANCE - STEADY STATE VEHICLE PERFORMANCE ANALYSIS WITH DETAILED EMPHASIS ON ELECTRIC POWER DRIVE PARAMETERS. ENERGY USAGE, HEAT REJECTION, AND FUEL IMPACT ARE ALSO CALCULATED.

2.) VEHICLE ACCELERATION PERFORMANCE - DYNAMIC VEHICLE PERFORMANCE ANALYSIS WHICH REALISTICALLY SIMULATES GROSS VEHICLE MISSION OVER ALL TERRAIN CONDITIONS. ACCELERATION, DECELERATION, BRAKING AND CONSTANT VELOCITY CONDITIONS ARE CONSIDERED.

3.) ACCELERATION DYNAMICS ROUTINE - DETAILED ANALYSIS OF FULL POWER VEHICLE ACCELERATION DURING TURNING AND NON-TURNING MANEUVERS ON USER SELECTED GRADES AND SURFACES. INCREMENTAL DYNAMIC PARAMETERS ARE GENERATED AND TABULATED.

4.) REDUCTION DYNAMICS ROUTINE - DETAILED ANALYSIS OF SPEED/TORQUE LOADING OF ALL VEHICLE POWER TRAIN REDUCTION ELEMENTS. FINAL SPROCKET DRIVES AND DIESEL ENGINE INTERFACE ARE INCLUDED IN ANALYSIS.

COURSE DATA

COURSE: DATA INPUT BY USER

SURFACE: COMPACTED SOIL

COEFFICIENT OF FRICTION= .7

PERFORMANCE LIMITS

MAX. COURSE VELOCITY, mph= 45

MAX. LAT. ACCEL., g's= .5

VEHICLE DATA

GROSS VEHICLE WEIGHT, tons= 19.5

FRONTAL AREA, sq. ft.= 57

COEFFICIENT OF DRAG= 1

TREAD WIDTH, in.= 92.5

TRACK LENGTH, in.= 150

TRACK PITCH, in.= 6.03

NUMBER OF SPROCKET TEETH= 11

ROLLING RESISTANCE, lb. per ton= 100

MAXIMUM VELOCITY, mph= 45

ENGINE DATA

ENGINE: VTA-903

MAX. POWER, hp= 500

MAX. SPEED, rpm= 2960

SPEED FOR MIN. FUEL, rpm= 2100

COOLING LOSSES, % Ghp= 4

INLET/EXHAUST LOSSES, % Ghp= 1.5

AUXILIARY POWER hp= 6

FUEL CAPACITY, gal.= 175

SCHEDULING: CONSTANT

ELECTRIC DRIVE DATA

TYPE: HoPol P-G

PEAK MOTOR EFF., %= 90

GENERATOR EFF., %= .92

MOTOR KM V/Krpm-A= .005

GEN. KG, V/Krpm-A= .005

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	1	1000	60	0	272.73	1000	272.73	2.50	17.31

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
2.50	22.02	0.000	73.40	39.80	9686.34	73.40	39.80	9686.34	29.46

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.30	96056.88	96056.88	67756.57	2600.00	199.18	1.915	173.09	0.10

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	269.21	663.35	599.16	75.67	663.35	599.16	75.67

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
1.00	270557.00	1.00	135278.50	15.0	1.00	135278.50	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	2	1000	57.5	0	227.27	2000	500.00	2.73	20.69

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
3.00	21.39	0.000	85.59	47.76	9411.56	85.59	47.76	9411.56	34.24

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.93	80310.51	176367.40	52813.05	2600.00	199.97	1.602	171.48	0.12

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	270.24	796.02	582.16	88.23	796.02	582.16	88.23

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
1.19	226326.80	1.19	113163.40	15.0	1.19	113163.40	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	3	1000	49.5	0	151.52	3000	651.52	3.14	31.05

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
4.50	19.25	0.000	115.55	71.64	8471.20	115.55	71.64	8471.20	46.25

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.69	53514.22	229881.60	28764.16	2600.00	199.85	1.067	170.42	0.18

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	270.09	1194.03	523.99	119.13	1194.03	523.99	119.13
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
1.79	150798.90	1.79	75399.44	15.0	1.79	75399.44	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	4	1000	42	0	113.64	4000	765.15	3.57	41.58

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
6.00	17.06	0.000	136.49	95.52	7504.59	136.49	95.52	7504.59	54.83

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.89	39991.02	269872.60	18065.08	2600.00	198.99	0.797	169.62	0.24

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	268.96	1592.04	464.20	140.71	1592.04	464.20	140.71
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
2.39	112625.00	2.39	56312.49	15.0	2.39	56312.49	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	5	1000	35.3	0	90.91	5000	856.06	3.98	51.98

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
7.50	14.94	0.000	149.44	119.40	6573.10	149.44	119.40	6573.10	60.03

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.86	31991.15	301863.80	12786.72	2600.00	198.97	0.638	168.98	0.30

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	268.94	1990.05	406.58	154.06	1990.05	406.58	154.06
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
2.99	90094.49	2.99	45047.25	15.0	2.99	45047.25	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	6	1000	28.8	0	75.76	6000	931.82	4.39	62.72

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
9.00	12.76	0.000	153.10	143.28	5611.78	153.10	143.28	5611.78	61.79

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
495.57	26536.36	328400.10	10140.59	2600.00	197.87	0.528	168.45	0.36

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	267.49	2388.06	347.12	157.83	2388.06	347.12	157.83
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
3.58	74675.68	3.58	37337.84	15.0	3.58	37337.84	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	7	1000	24	0	64.94	7000	996.75	4.79	72.81

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
10.50	11.07	0.000	154.98	167.16	4869.35	154.98	167.16	4869.35	62.29

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.63	22839.93	351240.10	8613.30	2600.00	198.86	0.455	168.00	0.42

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	268.79	2786.07	301.20	159.78	2786.07	301.20	159.78
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
4.18	64317.49	4.18	32158.75	15.0	4.18	32158.75	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	8	1000	20.4	0	56.82	8000	1053.57	5.18	83.13

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
12.00	9.77	0.000	156.30	191.04	4296.88	156.30	191.04	4296.88	62.76

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.05	20001.95	371242.00	7447.89	2600.00	199.06	0.399	167.60	0.48

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.06	3184.08	265.79	161.13	3184.08	265.79	161.13
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
4.78	56333.56	4.78	28166.78	15.0	4.78	28166.78	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	9	1000	17.6	0	50.51	9000	1104.08	5.56	93.62

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
13.50	8.74	0.000	157.30	214.93	3843.81	157.30	214.93	3843.81	63.22

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.60	17763.41	389005.40	6533.06	2600.00	198.85	0.354	167.24	0.53

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	268.77	3582.09	237.76	162.16	3582.09	237.76	162.16

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
5.37	50021.52	5.37	25010.76	15.0	5.37	25010.76	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	10	1000	15.4	0	45.45	10000	1149.53	5.93	104.05

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
15.00	7.92	0.000	158.41	238.81	3483.99	158.41	238.81	3483.99	63.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.48	15983.15	404988.60	5804.08	2600.00	198.79	0.319	166.93	0.59

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	268.70	3980.10	215.50	163.31	3980.10	215.50	163.31
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
5.97	45006.52	5.97	22503.26	15.0	5.97	22503.26	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	11	1000	13.7	0	41.32	11000	1190.85	6.30	113.95

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
16.50	7.28	0.000	160.27	262.69	3204.36	160.27	262.69	3204.36	64.19

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.34	14584.39	419573.00	5222.31	2600.00	199.68	0.291	166.64	0.65

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.86	4378.11	198.21	165.22	4378.11	198.21	165.22
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
6.57	41092.89	6.57	20546.45	15.0	6.57	20546.45	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	12	1000	12.2	0	37.88	12000	1228.73	6.66	124.40

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
18.00	6.72	0.000	161.32	286.57	2956.65	161.32	286.57	2956.65	64.65

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.04	13361.01	432934.00	4722.66	2600.00	199.54	0.266	166.37	0.71

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.68	4776.12	182.89	166.31	4776.12	182.89	166.31
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
7.16	37642.21	7.16	18821.11	15.0	7.16	18821.11	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	13	1000	10.8	0	34.97	13000	1263.70	7.02	135.03

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
19.50	6.19	0.000	161.06	310.45	2724.73	161.06	310.45	2724.73	64.65

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.22	12313.09	445247.10	4352.32	2600.00	199.15	0.245	166.12	0.77

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.16	5174.13	168.54	166.04	5174.13	168.54	166.04
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
7.76	34680.55	7.76	17340.28	15.0	7.76	17340.28	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	C.MPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	14	1000	9.640001	0	32.47	14000	1296.16	7.37	145.26

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
21.00	5.76	0.000	161.22	334.33	2532.67	161.22	334.33	2532.67	64.66

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.65	11443.52	456690.60	4043.90	2600.00	199.35	0.228	165.90	0.83

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.44	5572.14	156.66	166.21	5572.14	156.66	166.21
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
8.36	32235.98	8.36	16117.99	15.0	8.36	16117.99	15.0

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**** ELECTRIC DRIVE PERFORMANCE ****

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**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	15	1000	8.600001	0	30.30	15000	1326.47	7.71	155.86

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
22.50	5.37	0.000	161.00	358.21	2360.61	161.00	358.21	2360.61	64.65

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.07	10668.15	467358.80	3771.22	2600.00	199.07	0.213	165.68	0.89

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.07	5970.15	146.02	165.98	5970.15	146.02	165.98
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
8.96	30046.01	8.96	15023.01	15.0	8.96	15023.01	15.0

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**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	16	1000	7.74	0	28.41	16000	1354.88	8.06	165.79

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
24.00	5.04	0.000	161.43	382.09	2218.99	161.43	382.09	2218.99	64.67

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.21	10024.34	477383.10	3541.20	2600.00	199.62	0.200	165.48	0.95

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	269.79	6368.16	137.26	166.42	6368.16	137.26	166.42

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
9.55	28243.41	9.55	14121.70	15.0	9.55	14121.70	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	17	1000	6.95	0	26.74	17000	1381.61	8.39	176.08

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET			OUTER SPROCKET			NET DRIVE EFFICIENCY (%)
			HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	
25.50	4.75	0.000	161.49	405.97	2089.29	161.49	405.97	2089.29	64.68

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.38	9437.89	486821.00	3333.69	2600.00	199.70	0.188	165.29	1.01

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
		SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.89	6766.17	129.23	166.49	6766.17	129.23	166.49
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
10.15	26592.58	10.15	13296.29	15.0	10.15	13296.29	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	18	1000	6.25	0	25.25	18000	1406.87	8.73	186.27

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
27.00	4.49	0.000	161.64	429.85	1975.01	161.64	429.85	1975.01	64.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.77	8920.53	495741.60	3150.21	2600.00	199.89	0.178	165.12	1.06

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	270.14	7164.18	122.17	166.64	7164.18	122.17	166.64

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
10.75	25138.04	10.75	12569.02	15.0	10.75	12569.02	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	19	1000	5.6	0	23.92	19000	1430.79	9.06	196.79

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
28.50	4.25	0.000	161.50	453.73	1869.40	161.50	453.73	1869.40	64.68

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.39	8444.59	504186.20	2982.82	2600.00	199.71	0.168	164.95	1.12

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	269.90	7562.19	115.63	166.49	7562.19	115.63	166.49

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
11.34	23793.88	11.34	11896.94	15.0	11.34	11896.94	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	20	1000	5	0	22.73	20000	1453.52	9.39	207.56

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
30.00	4.03	0.000	161.19	477.61	1772.51	161.19	477.61	1772.51	64.66

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
498.57	8009.08	512195.20	2830.39	2600.00	199.31	0.160	164.79	1.19

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	269.38	7960.20	109.64	166.17	7960.20	109.64	166.17

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
11.94	22560.66	11.94	11280.33	15.0	11.94	11280.33	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	21	1000	4.5	0	21.64	21000	1475.16	9.71	217.30

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
31.50	3.85	0.000	161.65	501.49	1692.92	161.65	501.49	1692.92	64.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.79	7646.40	519841.70	2700.24	2600.00	199.90	0.153	164.64	1.24

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	270.15	8358.22	104.72	166.65	8358.22	104.72	166.65
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
12.54	21547.67	12.54	10773.84	15.0	12.54	10773.84	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	22	1000	4	0	20.66	22000	1495.82	10.03	228.00

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
33.00	3.67	0.000	161.41	525.37	1613.57	161.41	525.37	1613.57	64.67

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.15	7289.51	527131.10	2575.19	2600.00	199.59	0.145	164.49	1.30

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.75	8756.23	99.81	166.40	8756.23	99.81	166.40
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
13.13	20537.63	13.13	10268.82	15.0	13.13	10268.82	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	23	1000	3.56	0	19.76	23000	1515.59	10.35	238.15

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
34.50	3.51	0.000	161.54	549.25	1544.73	161.54	549.25	1544.73	64.68

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.52	6977.67	534108.80	2464.48	2600.00	199.77	0.139	164.35	1.36

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.98	9154.25	95.55	166.54	9154.25	95.55	166.54
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
13.73	19661.41	13.73	9830.71	15.0	13.73	9830.71	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	24	1000	3.15	0	18.94	24000	1534.53	10.67	248.35

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
36.00	3.37	0.000	161.64	573.14	1481.28	161.64	573.14	1481.28	64.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.78	6690.49	540799.30	2362.68	2600.00	199.90	0.133	164.22	1.42

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	270.14	9552.26	91.63	166.64	9552.26	91.63	166.64
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
14.33	18853.83	14.33	9426.91	15.0	14.33	9426.91	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	25	1000	2.75	0	18.18	25000	1552.71	10.98	259.12

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
37.50	3.23	0.000	161.39	597.02	1419.81	161.39	597.02	1419.81	64.67

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.11	6414.24	547213.60	2266.04	2600.00	199.57	0.128	164.09	1.48

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.72	9950.26	87.82	166.38	9950.26	87.82	166.38
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
14.93	18071.39	14.93	9035.70	15.0	14.93	9035.70	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	26	1000	2.4	0	17.48	26000	1570.19	11.30	269.08

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
39.00	3.11	0.000	161.63	620.90	1367.17	161.63	620.90	1367.17	64.68

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.73	6175.19	553388.80	2180.78	2600.00	199.87	0.123	163.97	1.54

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	270.11	10348.27	84.57	166.62	10348.27	84.57	166.62
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
15.52	17401.44	15.52	8700.72	15.0	15.52	8700.72	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	27	1000	2.05	0	16.83	27000	1587.03	11.61	279.81

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
40.50	2.99	0.000	161.41	644.78	1314.81	161.41	644.78	1314.81	64.67

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.17	5939.78	559328.50	2098.35	2600.00	199.60	0.118	163.85	1.60

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	269.76	10746.28	81.33	166.41	10746.28	81.33	166.41
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
16.12	16734.97	16.12	8367.49	15.0	16.12	8367.49	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	28	1000	1.74	0	16.23	28000	1603.26	11.91	289.76

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
42.00	2.89	0.000	161.63	668.66	1269.58	161.63	668.66	1269.58	64.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.75	5734.37	565062.90	2025.07	2600.00	199.88	0.114	163.73	1.66

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	270.13	11144.29	78.53	166.63	11144.29	78.53	166.63

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
16.72	16159.34	16.72	8079.67	15.0	16.72	8079.67	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	29	1000	1.44	0	15.67	29000	1618.93	12.22	299.97

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
43.50	2.79	0.000	161.71	692.54	1226.35	161.71	692.54	1226.35	64.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
499.94	5538.76	570601.60	1955.77	2600.00	199.97	0.110	163.62	1.71

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	270.25	11542.30	75.86	166.71	11542.30	75.86	166.71
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
17.31	15609.09	17.31	7804.55	15.0	17.31	7804.55	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	30	1000	1	0	15.15	30000	1634.08	12.52	317.52

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
45.00	2.64	0.000	158.15	716.42	1159.39	158.15	716.42	1159.39	64.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
490.49	5252.86	575854.50	1865.52	2600.00	195.43	0.104	163.52	1.81

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	264.30	11940.30	71.71	163.04	11940.30	71.71	163.04
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
17.91	14756.74	17.91	7378.37	15.0	17.91	7378.37	15.0

ELECTRIC VEHICLE MISSION SIMULATION

DC Homopolar Motor Drive System
40.0 TON

FMC / NORTHERN ORDNANCE DIVISION
MINNEAPOLIS, MINNESOTA USA

REVISION DATE: 06/05/85
RUN DATE: 08-22-1985

ELECTRICALLY DRIVEN, TRACKED VEHICLE PERFORMANCE IS SIMULATED BY THIS PROGRAM. DETAILED ASPECTS OF VEHICLE PERFORMANCE CAN BE INVESTIGATED USING THE FOUR RESIDENT SUB-PROGRAMS LISTED BELOW. THE SUB-PROGRAM IN USE IS IDENTIFIED WITH AN ASTERISK.

* 1.) ELECTRIC DRIVE PERFORMANCE -	STEADY STATE VEHICLE PERFORMANCE ANALYSIS WITH DETAILED EMPHASIS ON ELECTRIC POWER DRIVE PARAMETERS. ENERGY USAGE, HEAT REJECTION, AND FUEL IMPACT ARE ALSO CALCULATED.
2.) VEHICLE ACCELERATION PERFORMANCE -	DYNAMIC VEHICLE PERFORMANCE ANALYSIS WHICH REALISTICALLY SIMULATES GROSS VEHICLE MISSION OVER ALL TERRAIN CONDITIONS. ACCELERATION, DECELERATION, BRAKING AND CONSTANT VELOCITY CONDITIONS ARE CONSIDERED.
3.) ACCELERATION DYNAMICS ROUTINE -	DETAILED ANALYSIS OF FULL POWER VEHICLE ACCELERATION DURING TURNING AND NON-TURNING MANEUVERS ON USER SELECTED GRADES AND SURFACES. INCREMENTAL DYNAMIC PARAMETERS ARE GENERATED AND TABULATED.
4.) REDUCTION DYNAMICS ROUTINE -	DETAILED ANALYSIS OF SPEED/TORQUE LOADING OF ALL VEHICLE POWER TRAIN REDUCTION ELEMENTS. FINAL SPROCKET DRIVES AND DIESEL ENGINE INTERFACE ARE INCLUDED IN ANALYSIS.

COURSE DATA	VEHICLE DATA	ENGINE DATA	ELECTRIC DRIVE DATA
COURSE: DATA INPUT BY USER	GROSS VEHICLE WEIGHT, tons= 40.0	ENGINE: AD-1000	TYPE: HoPol P-G
SURFACE: COMPACTED SOIL	FRONTAL AREA, sq. ft.= 68.25	MAX. POWER, hp= 1000	PEAK MOTOR EFF., %= 90
COEFFICIENT OF FRICTION= .7	COEFFICIENT OF DRAG= 1	MAX. SPEED, rpm= 3725	GENERATOR EFF., %= .92
PERFORMANCE LIMITS	TREAD WIDTH, in.= 109.84	SPEED FOR MIN. FUEL, rpm= 2400	MOTOR KM V/Krpm-A= .005
	TRACK LENGTH, in.= 183.07	COOLING LOSSES, % Ghp= 4	GEN. KG, V/Krpm-A= .005
MAX. COURSE VELOCITY, mph= 45	TRACK PITCH, in.= 7.625	INLET/EXHAUST LOSSES, % Ghp= 1.5	
MAX. LAT. ACCEL., g's= .5	NUMBER OF SPROCKET TEETH= 11	AUXILIARY POWER hp= 12	
	ROLLING RESISTANCE, lb. per ton= 100	FUEL CAPACITY, gal.= 350	
	MAXIMUM VELOCITY, mph= 45	SCHEDULING: CONSTANT	

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	1	1000	60	0	145.07	1000	145.07	4.70	32.45

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
4.70	45.16	0.000	283.09	59.17	25126.20	283.09	59.17	25126.20	56.69

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.78	102412.50	102412.50	44358.01	3200.00	399.41	2.043	347.96	0.09

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.95	1479.34	1036.13	291.84	1479.34	1036.13	291.84
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
2.22	261356.30	2.22	130678.10	15.0	2.22	130678.10	15.0

**** ELECTRIC DRIVI PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	2	1000	49.4	0	113.64	2000	258.70	5.27	41.62

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
6.00	39.44	0.000	315.58	75.54	21941.26	315.58	75.54	21941.26	63.43

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
995.06	79924.40	182336.90	29228.82	3200.00	397.63	1.593	346.36	0.12

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	577.62	1888.52	904.79	325.34	1888.52	904.79	325.34

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER SPROCKET MOTOR VOLTAGE (volts)	INNER SPROCKET MOTOR CURRENT (amps)	INNER SPROCKET MOTOR FIELD POWER (Kw)	OUTER SPROCKET MOTOR VOLTAGE (volts)	OUTER SPROCKET MOTOR CURRENT (amps)	OUTER SPROCKET MOTOR FIELD POWER (Kw)
2.83	203903.50	2.83	101951.80	15.0	2.83	101951.80	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	3	1000	38.8	0	90.91	3000	349.61	5.85	52.19

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
7.50	32.95	0.000	329.55	94.43	18330.20	329.55	94.43	18330.20	66.41

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
992.41	63769.32	246106.20	21417.14	3200.00	396.36	1.270	345.09	0.15

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	575.95	2360.66	755.88	339.75	2360.66	755.88	339.75
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
3.54	162652.40	3.54	81326.19	15.0	3.54	81326.19	15.0

**** ELECTRIC DRIV. PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	4	1000	31.3	0	75.76	4000	425.37	6.41	62.08

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
9.00	27.91	0.000	335.01	113.31	15527.92	335.01	113.31	15527.92	67.02

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
999.65	53528.72	299634.90	17651.26	3200.00	399.83	1.068	344.03	0.18

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	580.50	2832.79	640.33	345.37	2832.79	640.33	345.37

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
4.25	136615.00	4.25	68307.50	15.0	4.25	68307.50	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	5	1000	25.9	0	64.94	5000	490.31	6.96	72.62

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
10.50	24.08	0.000	337.16	132.20	13395.19	337.16	132.20	13395.19	67.61

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
997.40	45778.49	345413.40	14828.73	3200.00	398.75	0.913	343.11	0.21

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.09	3304.92	552.38	347.59	3304.92	552.38	347.59
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
4.96	116813.20	4.96	58406.58	15.0	4.96	58406.58	15.0

**** ELECTRIC DRIVL PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	6	1000	22.1	0	56.82	6000	547.12	7.48	82.85

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
12.00	21.29	0.000	340.69	151.08	11843.66	340.69	151.08	11843.66	68.21

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.93	40117.60	385531.00	12752.66	3200.00	399.49	0.800	342.31	0.24

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	580.05	3777.05	488.40	351.23	3777.05	488.40	351.23

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
5.67	102381.20	5.67	51190.62	15.0	5.67	51190.62	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	7	1000	19.1	0	50.51	7000	597.63	7.99	93.46

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
13.50	19.04	0.000	342.81	169.97	10592.96	342.81	169.97	10592.96	68.79

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
996.62	35577.47	421108.50	11102.28	3200.00	398.38	0.709	341.60	0.27

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	578.59	4249.18	436.82	353.41	4249.18	436.82	353.41

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
6.37	90777.19	6.37	45388.60	15.0	6.37	45388.60	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	8	1000	16.8	0	45.45	8000	643.08	8.49	103.79

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
15.00	17.29	0.000	345.95	188.85	9621.06	345.95	188.85	9621.06	69.39

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
997.08	32034.69	453143.20	9805.11	3200.00	398.60	0.639	340.97	0.30

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	578.89	4721.31	396.74	356.65	4721.31	396.74	356.65
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
7.08	81740.88	7.08	40870.45	15.0	7.08	40870.45	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	9	1000	14.8	0	41.32	9000	684.41	8.97	114.02

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
16.50	15.76	0.000	346.80	207.74	8767.86	346.80	207.74	8767.86	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.18	29154.57	482297.70	8896.30	3200.00	399.13	0.581	340.38	0.33

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.58	5193.44	361.56	357.52	5193.44	361.56	357.52
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
7.79	74398.68	7.79	37199.34	15.0	7.79	37199.34	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	10	1000	13.1	0	37.88	10000	722.28	9.44	124.37

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
18.00	14.45	0.000	346.83	226.62	8037.85	346.83	226.62	8037.85	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.26	26727.01	509024.70	8155.44	3200.00	399.16	0.533	339.85	0.36

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.62	5665.57	331.46	357.55	5665.57	331.46	357.55
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
8.50	68204.25	8.50	34102.13	15.0	8.50	34102.13	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	11	1000	11.65	0	34.97	11000	757.25	9.91	134.88

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
19.50	13.32	0.000	346.50	245.51	7412.52	346.50	245.51	7412.52	69.48

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
997.38	24649.49	533674.20	7522.75	3200.00	398.74	0.491	339.36	0.39

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.07	6137.71	305.67	357.21	6137.71	305.67	357.21
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
9.21	62898.09	9.21	31449.05	15.0	9.21	31449.05	15.0

**** ELECTRIC DRIVL PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	12	1000	10.4	0	32.47	12000	789.72	10.37	145.51

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
21.00	12.35	0.000	345.94	264.39	6872.08	345.94	264.39	6872.08	69.47

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
995.92	22855.12	556529.30	6977.07	3200.00	398.04	0.456	338.90	0.42

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	578.15	6609.84	283.38	356.64	6609.84	283.38	356.64

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
9.91	58312.26	9.91	29156.13	15.0	9.91	29156.13	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	13	1000	9.38	0	30.30	13000	820.02	10.81	155.44

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
22.50	11.56	0.000	346.87	283.28	6431.04	346.87	283.28	6431.04	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.37	21383.92	577913.30	6524.92	3200.00	399.22	0.426	338.48	0.44

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.69	7081.97	265.20	357.59	7081.97	265.20	357.59

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER SPROCKET MOTOR VOLTAGE (volts)	INNER SPROCKET MOTOR CURRENT (amps)	INNER SPROCKET MOTOR FIELD POWER (Kw)	OUTER SPROCKET MOTOR VOLTAGE (volts)	OUTER SPROCKET MOTOR CURRENT (amps)	OUTER SPROCKET MOTOR FIELD POWER (Kw)
10.62	54569.79	10.62	27284.90	15.0	10.62	27284.90	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	14	1000	8.45	0	28.41	14000	848.43	11.26	165.81

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
24.00	10.84	0.000	346.85	302.16	6028.78	346.85	302.16	6028.78	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.32	20046.46	597959.70	6116.87	3200.00	399.19	0.400	338.08	0.47

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.66	7554.10	248.61	357.58	7554.10	248.61	357.58

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
11.33	51156.53	11.33	25578.27	15.0	11.33	25578.27	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	15	1000	7.65	0	26.74	15000	875.17	11.69	175.86

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
25.50	10.22	0.000	347.41	321.05	5683.37	347.41	321.05	5683.37	69.50

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
999.82	18895.57	616855.30	5764.06	3200.00	399.91	0.377	337.70	0.50

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	580.60	8026.23	234.37	358.16	8026.23	234.37	358.16

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
12.04	48225.57	12.04	24112.79	15.0	12.04	24112.79	15.0

**** ELECTRIC DRIV! PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	16	1000	6.88	0	25.25	16000	900.42	12.12	186.85

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
27.00	9.62	0.000	346.34	339.93	5351.01	346.34	339.93	5351.01	69.48

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
996.96	17794.81	634650.10	5431.21	3200.00	398.54	0.355	337.35	0.53

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	578.81	8498.36	220.66	357.05	8498.36	220.66	357.05
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
12.75	45405.39	12.75	22702.70	15.0	12.75	22702.70	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	17	1000	6.25	0	23.92	17000	924.34	12.55	196.75

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
28.50	9.13	0.000	347.10	358.82	5080.51	347.10	358.82	5080.51	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.98	16892.40	651542.50	5153.81	3200.00	399.51	0.337	337.01	0.56

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	580.08	8970.49	209.51	357.83	8970.49	209.51	357.83

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER SPROCKET MOTOR VOLTAGE (volts)	INNER SPROCKET MOTOR CURRENT (amps)	INNER SPROCKET MOTOR FIELD POWER (Kw)	OUTER SPROCKET MOTOR VOLTAGE (volts)	OUTER SPROCKET MOTOR CURRENT (amps)	OUTER SPROCKET MOTOR FIELD POWER (Kw)
13.46	43110.04	13.46	21555.02	15.0	13.46	21555.02	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

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**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	18	1000	5.65	0	22.73	18000	947.07	12.96	207.25

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
30.00	8.67	0.000	346.88	377.71	4823.40	346.88	377.71	4823.40	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.39	16038.31	667580.80	4893.78	3200.00	399.23	0.320	336.69	0.59

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.71	9442.63	198.90	357.60	9442.63	198.90	357.60

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
14.16	40928.39	14.16	20464.20	15.0	14.16	20464.20	15.0

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**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	19	1000	5.1	0	21.64	19000	968.72	13.38	217.88

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
31.50	8.25	0.000	346.49	396.59	4588.63	346.49	396.59	4588.63	69.48

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
997.37	15258.97	682839.70	4656.88	3200.00	398.74	0.304	336.39	0.62

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.07	9914.77	189.22	357.21	9914.77	189.22	357.21

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER SPROCKET MOTOR VOLTAGE (volts)	INNER SPROCKET MOTOR CURRENT (amps)	INNER SPROCKET MOTOR FIELD POWER (Kw)	OUTER SPROCKET MOTOR VOLTAGE (volts)	OUTER SPROCKET MOTOR CURRENT (amps)	OUTER SPROCKET MOTOR FIELD POWER (Kw)
14.87	38936.25	14.87	19468.13	15.0	14.87	19468.13	15.0

**** ELECTRIC DRIVI PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	20	1000	4.63	0	20.66	20000	989.38	13.79	227.71

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
33.00	7.89	0.000	347.25	415.48	4389.58	347.25	415.48	4389.58	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
999.37	14594.63	697434.30	4452.44	3200.00	399.70	0.291	336.09	0.65

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	580.33	10386.90	181.01	357.98	10386.90	181.01	357.98

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
15.58	37247.27	15.58	18623.63	15.0	15.58	18623.63	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	21	1000	4.17	0	19.76	21000	1009.14	14.19	238.27

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
34.50	7.54	0.000	346.96	434.36	4195.27	346.96	434.36	4195.27	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.61	13949.47	711383.80	4256.23	3200.00	399.33	0.278	335.82	0.68

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.85	10859.04	173.00	357.69	10859.04	173.00	357.69

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
16.29	35598.49	16.29	17799.25	15.0	16.29	17799.25	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	22	1000	3.75	0	18.94	22000	1028.08	14.60	248.73

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
36.00	7.22	0.000	346.84	453.25	4019.05	346.84	453.25	4019.05	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.29	13363.89	724747.60	4077.81	3200.00	399.18	0.267	335.55	0.71

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.64	11331.17	165.73	357.56	11331.17	165.73	357.56

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
17.00	34103.20	17.00	17051.60	15.0	17.00	17051.60	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	23	1000	3.38	0	18.18	23000	1046.26	15.00	258.57

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
37.50	6.95	0.000	347.48	472.13	3865.40	347.48	472.13	3865.40	69.50

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
999.99	12851.15	737598.80	3920.10	3200.00	399.99	0.256	335.29	0.74

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	580.71	11803.30	159.40	358.22	11803.30	159.40	358.22
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
17.70	32799.37	17.70	16399.69	15.0	17.70	16399.69	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	24	1000	3	0	17.48	24000	1063.74	15.39	269.64

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
39.00	6.66	0.000	346.63	491.02	3707.67	346.63	491.02	3707.67	69.48

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
997.74	12329.07	749927.80	3762.44	3200.00	398.91	0.246	335.05	0.77

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.30	12275.43	152.89	357.35	12275.43	152.89	357.35
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
18.41	31461.01	18.41	15730.50	15.0	18.41	15730.50	15.0

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	25	1000	2.67	0	16.83	25000	1080.58	15.78	279.82

**** VEHICLE PERFORMANCE DATA ****

FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	INNER SPROCKET HORSEPOWER (hp)	INNER SPROCKET SPEED (rpm)	INNER SPROCKET TORQUE (ft-lb)	OUTER SPROCKET HORSEPOWER (hp)	OUTER SPROCKET SPEED (rpm)	OUTER SPROCKET TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
40.50	6.42	0.000	346.84	509.90	3572.56	346.84	509.90	3572.56	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.30	11879.21	761807.00	3624.77	3200.00	399.19	0.237	334.81	0.80

**** ELECTRIC DRIVE DATA ****

GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	INNER SPROCKET MOTOR SPEED (rpm)	INNER SPROCKET MOTOR TORQUE (ft-lb)	INNER SPROCKET MOTOR HORSEPOWER (hp)	OUTER SPROCKET MOTOR SPEED (rpm)	OUTER SPROCKET MOTOR TORQUE (ft-lb)	OUTER SPROCKET MOTOR HORSEPOWER (hp)
10400.00	579.65	12747.56	147.32	357.57	12747.56	147.32	357.57

BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	INNER VOLTAGE (volts)	INNER CURRENT (amps)	INNER FIELD POWER (Kw)	OUTER VOLTAGE (volts)	OUTER CURRENT (amps)	OUTER FIELD POWER (Kw)
19.12	30314.50	19.12	15157.25	15.0	19.12	15157.25	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	26	1000	2.37	0	16.23	26000	1096.81	16.17	289.60

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
42.00	6.20	0.000	347.47	528.79	3451.18	347.47	528.79	3451.18	69.50

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
999.97	11474.03	773281.00	3500.03	3200.00	399.98	0.229	334.58	0.83

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	580.70	13219.69	142.32	358.21	13219.69	142.32	358.21
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
19.83	29284.57	19.83	14642.28	15.0	19.83	14642.28	15.0

**** ELECTRIC DRIV PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	27	1000	2.06	0	15.67	27000	1112.49	16.56	300.59

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
43.50	5.98	0.000	346.80	547.67	3325.76	346.80	547.67	3325.76	69.49

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
998.19	11058.69	784339.70	3374.47	3200.00	399.13	0.221	334.36	0.86

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	579.58	13691.81	137.14	357.53	13691.81	137.14	357.53
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
20.54	28220.36	20.54	14110.18	15.0	20.54	14110.18	15.0

**** ELECTRIC DRIV. PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
DATA INPUT BY USER	COMPACTED SOIL	45.00	0.50	40 TON	AD-1000	CONSTANT	HoPol P-G

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	28	1000	1.75	0	15.15	28000	1127.64	16.94	312.47

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (K-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
45.00	5.75	0.000	345.27	566.56	3200.76	345.27	566.56	3200.76	69.46

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
994.13	10646.64	794986.30	3251.25	3200.00	397.18	0.212	334.15	0.89

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
GENERATOR SPEED (rpm)	GENERATOR POWER (Kw)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
10400.00	577.03	14163.94	131.99	355.95	14163.94	131.99	355.95
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (Kw)
21.25	27159.65	21.25	13579.82	15.0	21.25	13579.82	15.0

APPENDIX C

CONFIGURATION III ANALYSIS

Title: CONFIGURATION III ANALYSIS

1. INTRODUCTION

FOR THE PURPOSE OF THIS ANALYSIS THE FINAL DRIVES ARE ASSUMED TO BE A CONVENTIONAL ARRANGEMENT OF SPUR REDUCTION GEARS COMBINED WITH A PLANETARY SECTION TO SUM THE PROPULSION AND STEER INPUTS.

THE APPROACH USED IS AS FOLLOWS:

- BRIEF DISCUSSION OF CONFIGURATION III
- GEAR AND POWER FLOW ANALYSIS
  - ASSUMPTIONS/BACKGROUND
  - ARRANGEMENT OF COMBINING PLANETARY
  - ARRANGEMENT #1
    - GEARING
    - POWER FLOW SCHEMATIC
  - ARRANGEMENT #2
    - GEARING
    - POWER FLOW SCHEMATIC
- RESULTS

Title:

2. DISCUSSION OF CONFIGURATION III

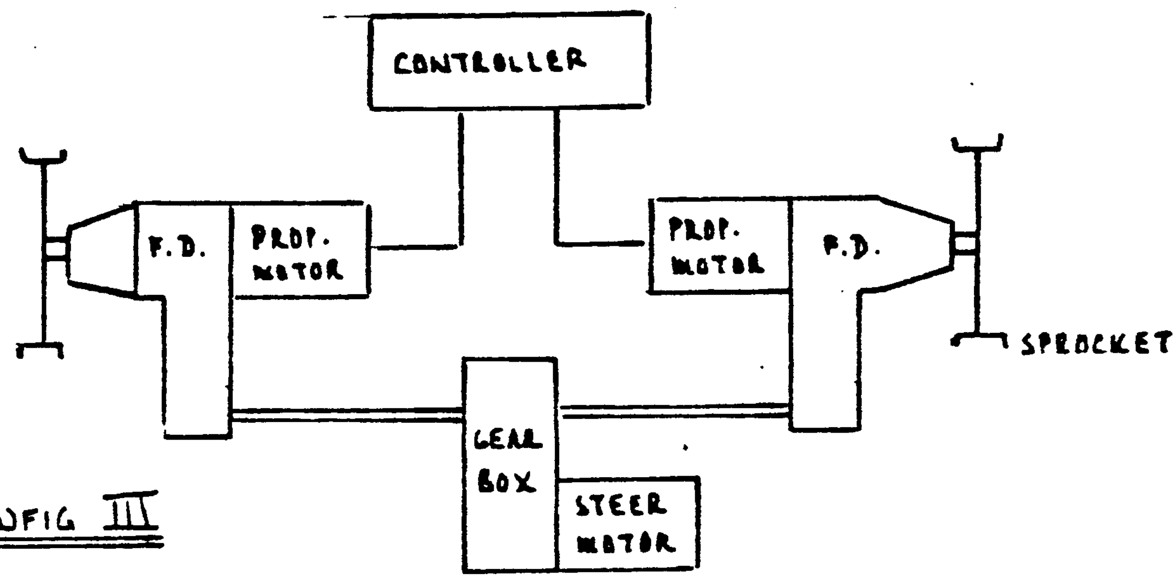
IN ORDER FOR CONFIGURATION III TO FUNCTION:

a) BOTH PROPULSION MOTORS MUST OPERATE AT IDENTICAL SPEEDS AND THUS CONTROL THE AVERAGE VEHICLE SPEED.

b) THE STEER MOTOR CONTROLS STEERING ONLY.

c) THE FINAL DRIVES MUST HAVE SOME TYPE OF COMBINING PLANETARY.

A SKETCH OF THIS CONFIGURATION APPEARS BELOW:



CONFIG III

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3. GEAR AND POWER FLOW ANALYSIS

THE FOLLOWING ANALYSIS IS TYPICAL FOR A PLANETARY GEAR SET BASED ON MATHEMATICAL PROCEDURES AND PLANETARY GEAR SET OPERATION.

a) ASSUMPTIONS / BACKGROUND :

SYMBOLS USED

$T \equiv$ TORQUE

$\omega \equiv$ ANGULAR VELOCITY

$N \equiv$ NO. OF TEETH

SUBSCRIPTS

S = SUN GEAR

I = INTERNAL GEAR

C = CAGE

SIGN CONVENTION

INPUT HP = + , OUTPUT HP = −

∴ INPUT SPEED AND TORQUE WILL HAVE THE SAME SIGN AND OUTPUT SPEED AND TORQUE WILL HAVE OPPOSITE SIGN. $\Sigma T = 0$. (PROOF @ P. C-10)

TORQUE RELATIONSHIP

$$T_S = -\frac{T_C}{1+M} \qquad \text{WHERE } M = \frac{N_I}{N_S}$$

$$T_I = -\frac{M}{1+M} T_C \qquad \therefore T_S + T_I = -T_C$$

b) ARRANGEMENT OF COMBINING PLANETARY :

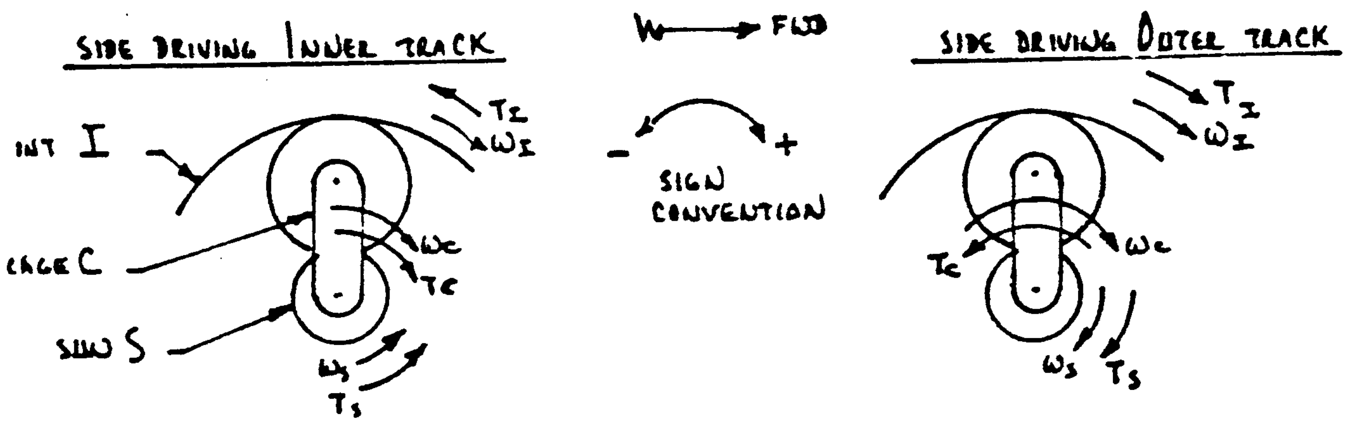
TWO ARRANGEMENTS WERE ANALYZED AS FOLLOWS

	# 1	# 2
CAGE	OUTPUT	
INTERNAL GEAR	PROP. MOTOR	STEER MOTOR
SUN GEAR	STEER MOTOR	PROP. MOTOR

ANALYSIS OF THESE ARRANGEMENTS PROVIDE THE BACKGROUND FROM WHICH CONFIGURATION III POWER FLOW ANALYSIS CAN BE DERIVED. ARRANGEMENT #1 IS ANALYZED FIRST FOR GEARING AND POWER FLOW; THEN ARRANGEMENT #2.

d) ARRANGEMENT #1 (INTERNAL = PROP. MOTOR, SUN = STEER MOTOR, CAGE = OUTPUT)

GEARING



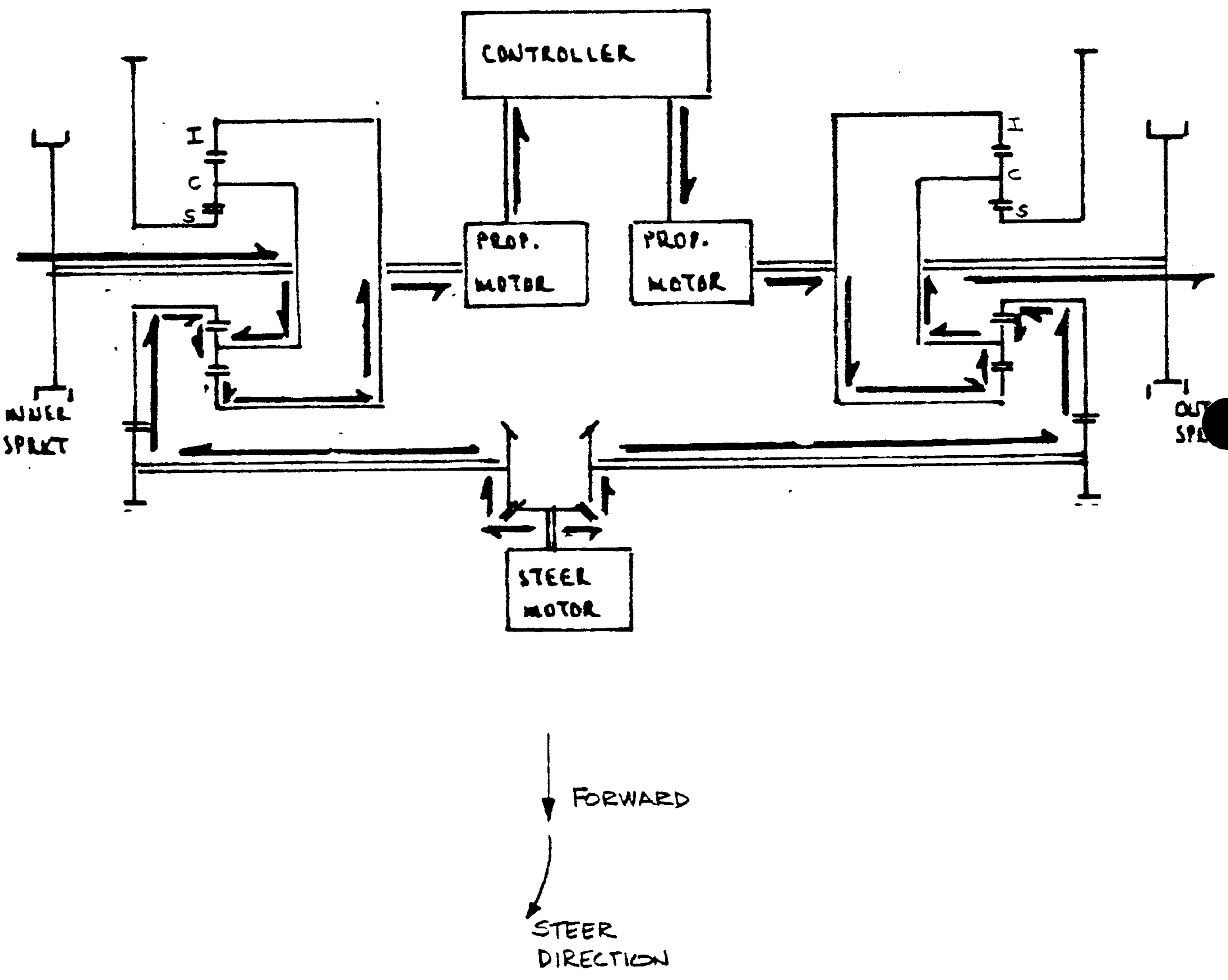
- SINCE THE SUN GEARS ARE DRIVEN BY THE STEER MOTOR, THEY MUST HAVE OPPOSING SPEEDS AS SHOWN ABOVE TO SLOW DOWN INNER TRACK AND SPEED UP OUTER TRACK.
- BY DEFINITION (PAGE 3) AT THE INNER TRACK SIDE, T_c & ω_c ARE SAME SIGN (BECAUSE OF REGENERATIVE HP FLOWING INTO UNIT FROM TRACKS). AT OUTER TRACK SIDE, THE SIGNS OPPOSE BECAUSE HP IS FLOWING OUT OF UNIT.
- FROM TORQUE RELATIONSHIP (PAGE 3), BOTH SUN TORQUE, T_s & INTERNAL GEAR TORQUE, T_I MUST BE OF OPPOSITE SIGN FROM CAGE TORQUE, T_c, SHOWN ABOVE.
- THE SIGNS OF SPEED, ω; TORQUE, T &; HP WILL THEN BE:

	INNER TRACK			OUTER TRACK		
	I	S	C	I	S	C
	PROP MOTOR	STEER MOTOR	OUTPUT	PROP MOTOR	STEER MOTOR	OUTPUT
ω	+	−	+	+	+	+
T	−	−	+	+	+	−
▲ HP	−	+	+	+	+	−

▲ SEE SIGN CONVENTION PREVIOUS PAGE: − = OUT, + = IN

POWER FLOW SCHEMATIC

REGENERATIVE HP FLOWS INTO THE PROPULSION MOTOR AND NOT THROUGH THE STEER CONTROL SHAFT.



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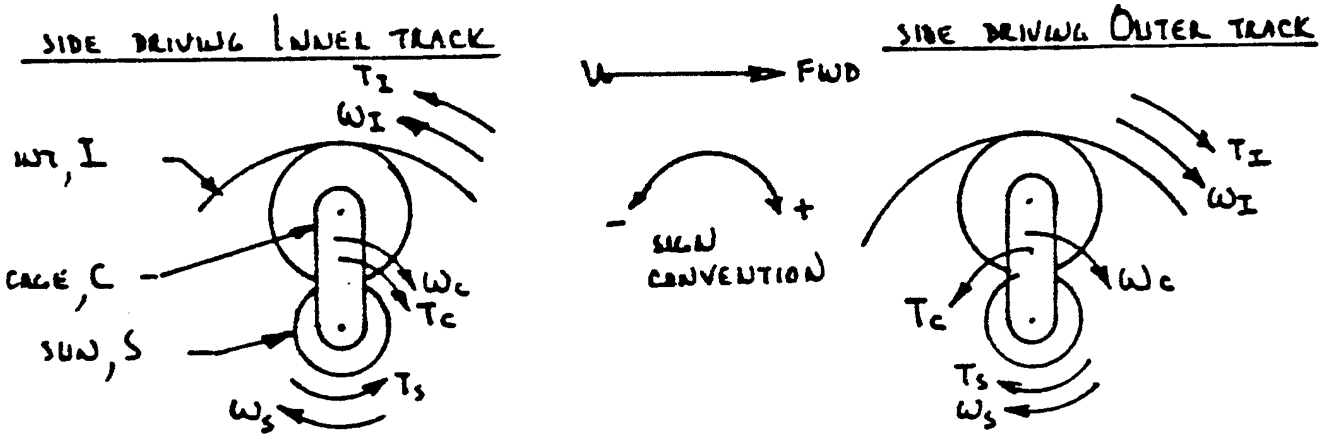
e) ARRANGEMENT #2 (INTERNAL = STEER MOTOR, SUN = PROP MOTOR, CAGE = OUTPUT)

GEARING



- SINCE THE INTERNAL GEARS ARE DRIVEN BY THE STEER MOTOR, THEY MUST HAVE OPPOSING SPEEDS AS SHOWN ABOVE.
- THE SIGNS OF THE TORQUE WILL BE THE SAME AS FOR ARRANGEMENT #1.
- THE SIGNS OF ω, T, HP WILL THEN BE :

	INNER TRACK			OUTER TRACK		
	I	S	C	I	S	C
	STEER MOTOR	PROP MOTOR	OUTPUT	STEER MOTOR	PROP MOTOR	OUTPUT
ω	−	+	+	+	+	+
T	−	−	+	+	+	−
▲ HP	+	−	+	+	+	−

▲ SEE SIGN CONVENTION ON PAGE 3 : − = OUT , + = IN

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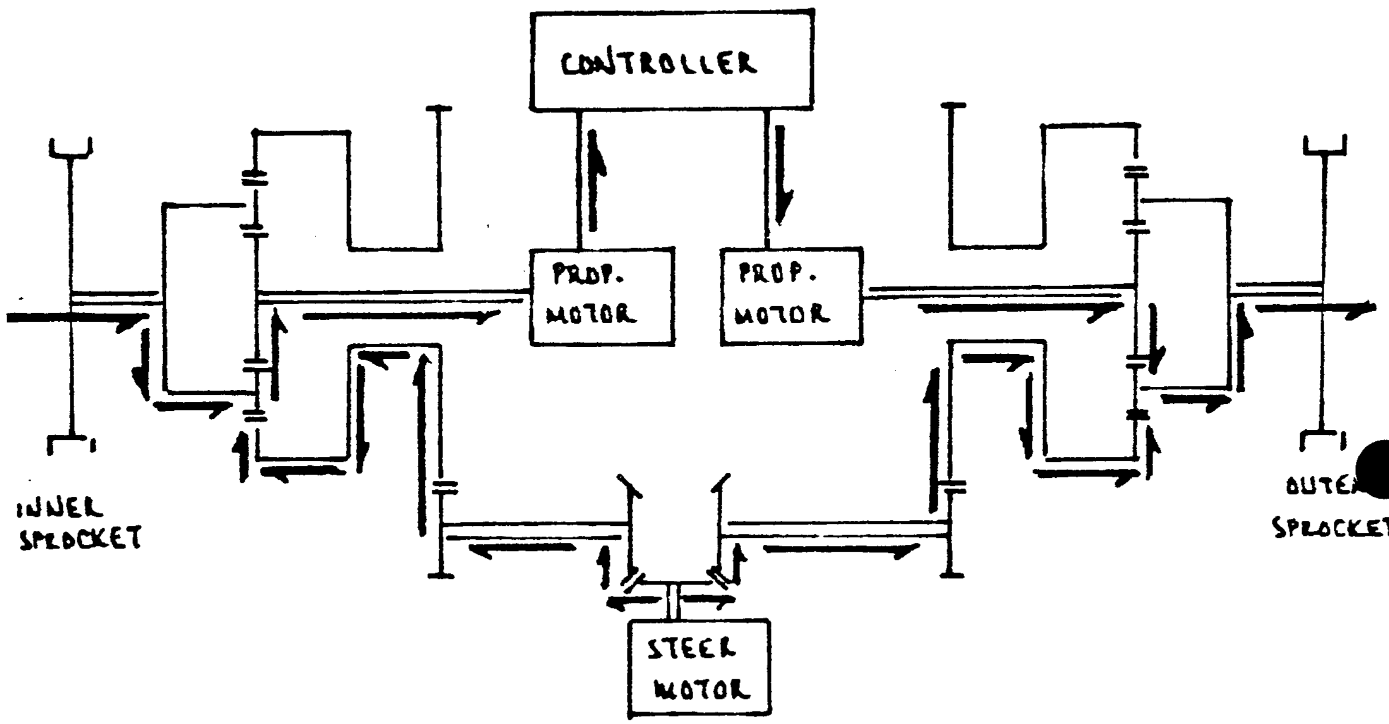
POWER FLOW SCHEMATIC

REGENERATIVE HP FLOWS INTO THE PROPULSION MOTOR, AND NOT THROUGH THE STEER CONTROL SHAFT.



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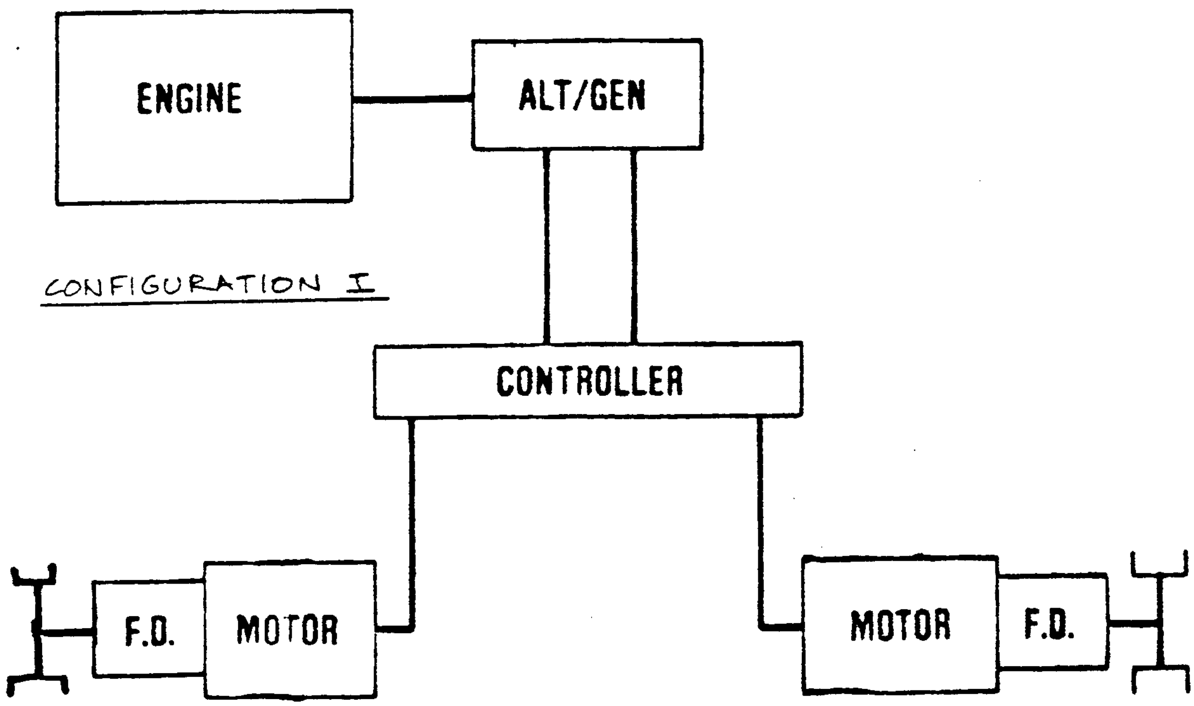
4. RESULTS

- IN BOTH ARRANGEMENTS, THE POWER FLOW IS INTO THE PROPULSION MOTOR (FROM STEERING REGENERATION)

- BECAUSE REGENERATED POWER FLOW IS THRU INNER TRACK PROPULSION MOTOR TO CONTROLLER TO OUTER TRACK PROPULSION MOTOR, MOTORS AND CONTROLLER MUST BE SIZED TO TRANSFER REGENERATIVE LOADS. THIS IS THE SAME MANNER IN WHICH CONFIGURATION I OPERATES (SHOWN BELOW)

CONFIGURATION I



- IT IS THE FUNCTION OF THE PROPULSION SYSTEM TO TRANSFER POWER EFFICIENTLY, BUT CONFIGURATION II HAS THE BURDEN OF CARRYING A STEER MOTOR AND SHAFTING TO ACCOMPLISH THE SAME TRANSFER THAT CONFIGURATION I CARRIES OUT. A SUMMARY OF THIS FACT IS ON THE NEXT PAGE.

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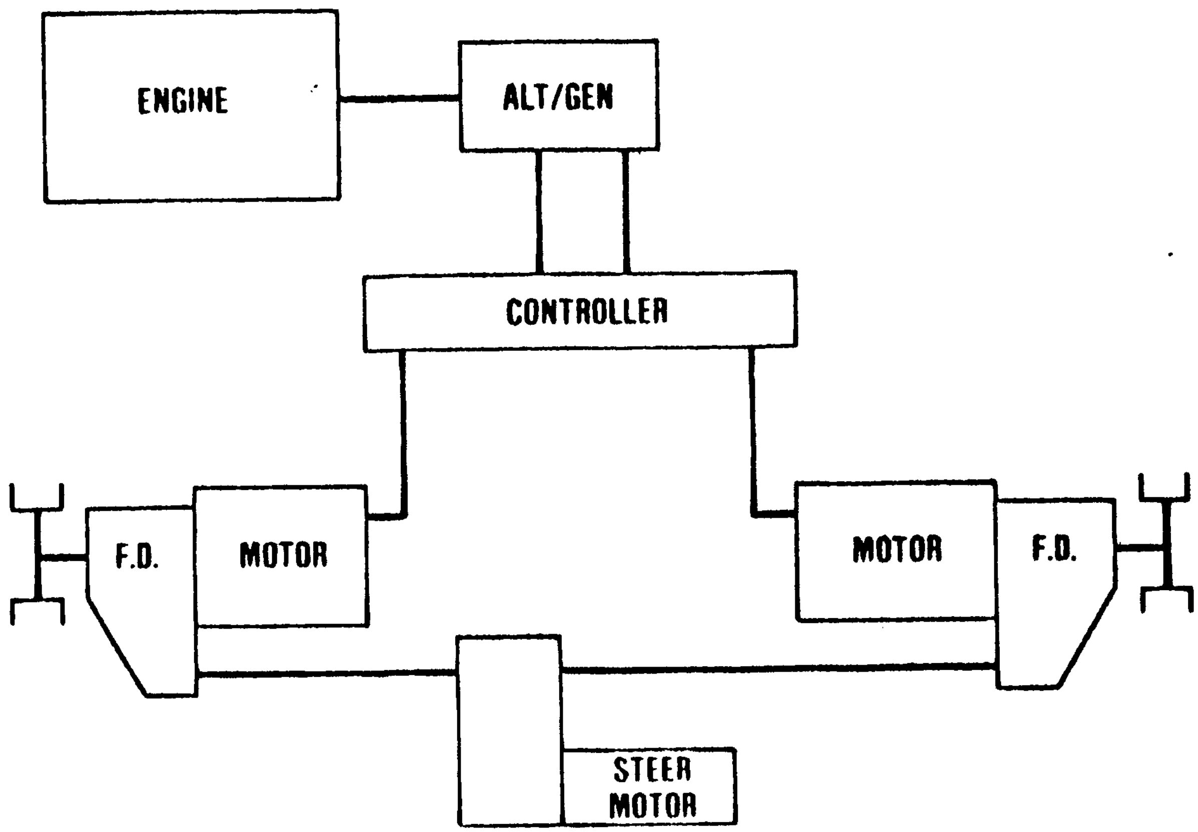
Configuration III



Detailed analysis shows regenerative HP flow is through the propulsion motors

∴ This arrangement has no advantage over Configuration I

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Title: SIGN OF INT & SUN TORK

DISCUSSION

IN A COMBINING PLANETARY, WHEN WE APPLY THE SIGN CONVENTION FOR HP (IE + = INPUT, — = OUTPUT) WE FIND THAT THE SUN & INT TORK MUST HAVE THE SAME SENSE (IE POSITIVE OR NEGATIVE SIGN).

WE WILL PROVE THE ABOVE PT. IN THE FOLLOWING ANALYSIS

CONVENTION

INPUT HP = +

OUTPUT HP = —

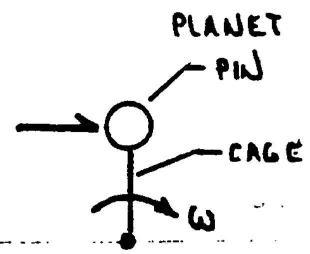
⟶ = APPLIED FORCE

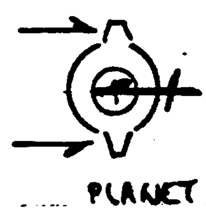
⟶ = REACTION FORCE

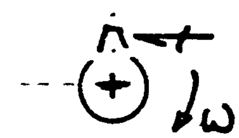
↷ = +ω

I a CAGE = OUTPUT

(PLANET TOOTH LOADS BOTH ARE "APPLY")







	INT	SUN
FORCES	REACTIVE	REACTIVE
DRIVE R OR N	DRIVER	DRIVE R
HP SIGN	+	+
ω SIGN	+	+
TORK SIGN	+	+

▲ ROTATION IS OPPOSITE TO DIRECTION OF REACTIVE FORCE

Signature: V. VIRATA   Date of Signature: 29 APR 85

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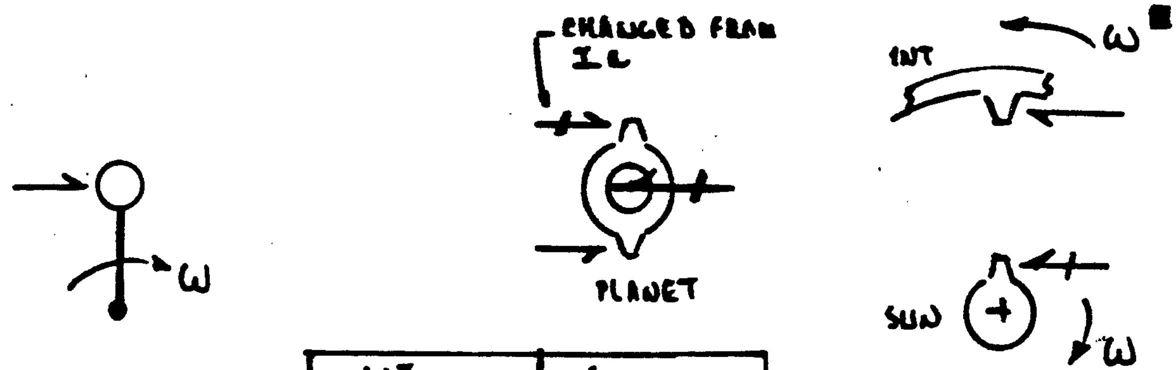
Title: SIGN OF INT & SUN TORK

Ib CAGE = OUTPUT

(PLANET TOOTH LOADS APPLY & REACTIVE)

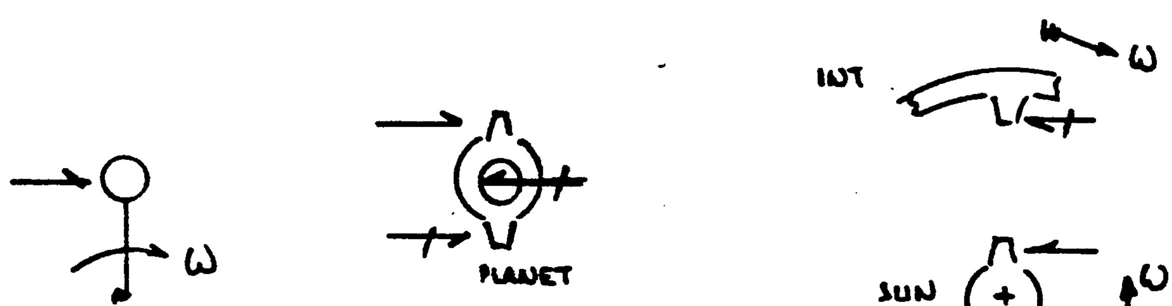


	INT	SUN
FORCES	APPLY	REACTIVE
DRIVE R OR N	DRIVE N	DRIVE R
IP SIGN	−	+
ω SIGN	−	+
TORK SIGN	+	+

■ ROTATION IS IN SAME DIRECTION AS APPLY FORCE

Ic CAGE = OUTPUT

(APPLY & REACTIVE FORCES SWAPPED FROM Ib)



	INT	SUN
FORCES	REACTIVE	APPLY
DRIVE R OR N	DRIVE R	DRIVE N
IP SIGN	+	−
ω SIGN	+	−
TORK SIGN	+	+

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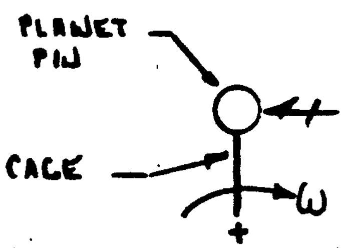
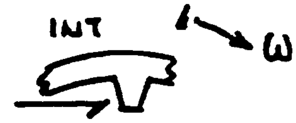
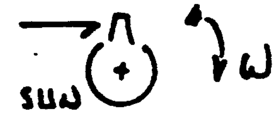
Title: SIGN OF INT. & SUN TORK

II a CAGE = INPUT

(BOTH PLANET LOADS ARE REACTIVE)



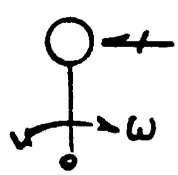


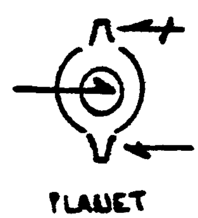


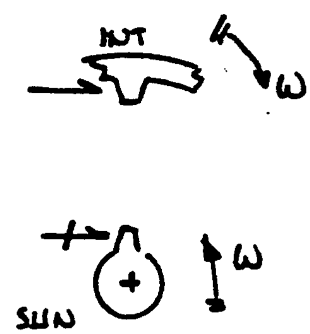
	INT	SUN
FORCES	APPLY	APPLY
DRIVER OR DRIVEN	DRIVE N	DRIVE N
W̃ SIGN	—	—
ω SIGN	+	+
TORK SIGN	—	—

II b CAGE = INPUT

(PLANET TOOTH LOADS ARE APPLY & REACTIVE)







	INT	SUN
FORCES	APPLY	REACTIVE
DRIVE R OR N	DRIVE N	DRIVE R
W̃ SIGN	—	+
ω SIGN	+	—
TORK SIGN	—	—

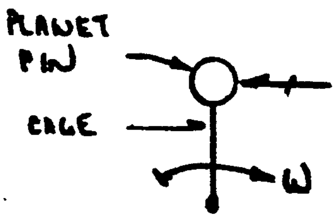
Signature: KH | Date of Signature: 29 APR 85

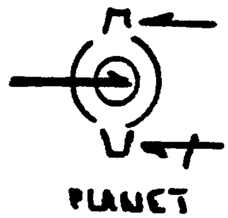
Signature | Date of Signature | Date Understood

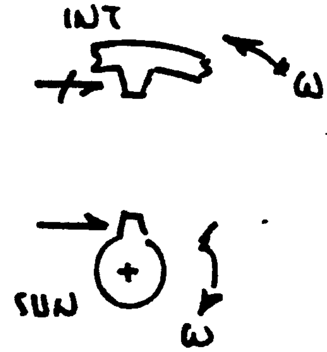
Title: SIGN OF INT & SUN TORK

II C CAGE = INPUT

(PLANET TOOTH LOADS SWAPPED FROM II b)







	INT	SUN
FORCES	REACTIVE	APPLY
DRIVE R OR N	DRIVE R	DRIVE N
UP SIGN	+	—
W SIGN	—	+
TORK SIGN	—	—

CONCLUSION

THERE ARE 6 POSSIBLE COMBINATIONS OF SUN : INT TORK AS SHOWN IN THE PRECEDING ANALYSIS. IN ALL 6 CASES, THE SIGNS OF THE TORK ARE THE SAME (IE BOTH POSITIVE OR BOTH NEGATIVE)

Signature	Date of Signature		Signature	Date of Signature	Date Understood
[signature]	29 APR 85	C-14			

APPENDIX D

CONFIGURATION IV ANALYSIS

Appendix D Configuration IV Analysis

The information in this appendix supplements the discussion in Section 5.2.6 in the main body of the report.

CVX 650 POWER

FLOW ANALYSIS

FMC Corporation

ENGINEERING SHEET

Division:

Project:

Title: XHM 650 Tout & HP

DISCUSSION

FROM ALLISON TABULATION OF SPDS & PARTIAL TABULATION OF TORKS, TOUT & HP WILL BE CALCULATED

NOTE.

(1) TOUT NOT TABULATED IN ALLISON DATA
HENCE DETERMINED BY

$$1 \text{ \& REV} : T_{OUT} = T_{S2}\left(\frac{59}{56}\,\frac{132}{90}\right)$$

$$2 : T_K\left(\frac{132}{90}\right)$$

(2) CALCUS FOR 3RD NOT PERFORMED SINCE THERE IS AN ERROR IN 3RD RANGE SPEEDS & PRESUMABLY IN TORK ALSO

(3) 100% GEAR EFF ASSUMED

(4) MAX "MOTOR" OUTPUT TORK OF 2437 IS FOR 100% PUMP-MOTOR TORK EFFICIENCY
IN FACT BOTH TORK & VOLUMETRIC EFF ARE ASSUMED TO BE 100% IN ALLISON TABLE SINCE PUMP HP = MOTOR HP
PUMP/MOTOR CIR = 35

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KH	1 AUG 85				

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▲ ABS SPD (IS ACTUALLY NEG.)
■ T_{I_2} ($\frac{52}{56}$ $\frac{132}{90}$) SINCE T_{OUT} NOT TAB.
▼ T_K ($\frac{132}{90}$) " " " "

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Project:
Page 2 of

Title: XHM 650 T_{OUT} : HP

	OUTPUT			INPUT			"PUMP"				"MOTOR"			
	RPM	LB FT	HP	RPM	LB FT	HP	RPM▲	LB FT	HP		RPM	LB FT	HP	
1	0	■10,982	0	2600	0	0	1938	0	P	0	0	2437	M	0
	1 00	■11,997	228	"	461	228	1774	615		209	451	2437		209
	2	■13,220	503	"	1017	503	1610	1364		418	901	2437		418
	3	■13,093	748	"	1510	748	1446	2026		558	1352	2168		558
	4	■9820	748	"	"	"	1282	"		495	1803	1442		495
	5	■7856	748	"	"	"	1119	"		432	2253	1806		432
	6	■6546	748	"	"	"	955	"		368	2704	715		368
2 LO	7	▼5606	747	"	"	"	1027	1796	M	351	2506	737	P	352
	8	▼4905	747	"	"	"	1173	1319		295	2102	"		295
	9	▼4360	747	"	"	"	1320	947		238	1699	"		238
	10 00	▼3923	747	"	"	"	1467	650		182	1296	"		182
	11	▼3567	747	"	"	"	1613	406		125	892	"		125
	12	▼3271	747	"	"	"	1760	204		68.4	490	"		68.8
	13	▼3018	747	"	"	"	1907	32		11.6	86	"		12.1
2 HI	14	▼2803	747	"	"	"	2053	115	P	45.0	-317	"	M	44.5
	15	▼2617	747	"	"	"	2200	242		101	-721	"		101
	16	▼2452	747	"	"	"	2347	354		158	-1124	"		158
3 LO	17			"	"				M				P	
	18			"	"									
	19			"	"									
	20 00			"	"									
	21			"	"									
	22			"	"									
3 HI	23			"	"				P				M	
	24			"	"									
	25			"	"									
	26			"	"									
	27			"	"									
	28			"	"									
	29			"	"									
	30 00			"	"									
	31			"	"									
	32			"	"									

Signature: KC | Date of Signature: 1 Aug 85 | Signature | Date of Signature | Date Understood

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Title: XHM 650 TOUT & HP

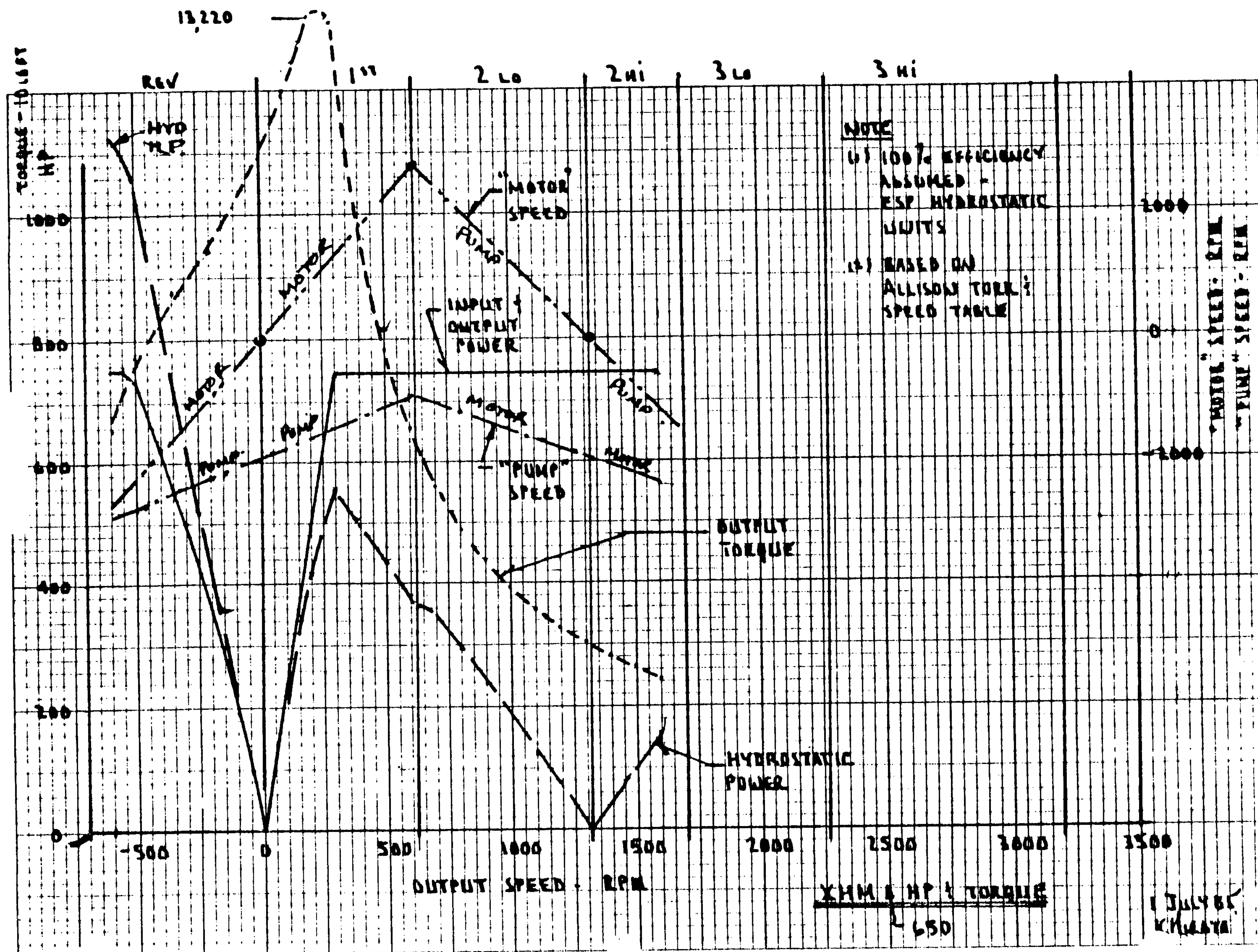
	OUTPUT			INPUT			"PUMP"				"MOTOR"			
	RPM	LB FT*	HP	RPM	LB FT	HP	RPM	LB FT		HP	RPM	LB FT		HP
REV	0	10,382	0	2600	0	0	-1938	0	P	0	0	2437	M	0
	-100	10127	193	"	389	193	-2102	523		209	-451	"		209
	-200	9397	358	"	721	357	-2266	968		418	-901	"		418
	-300	8762	500	"	1010	500	-2430	1356		627	-1352	"		627
	-400	8207	625	"	1263	625	-2593	1694		836	-1803	"		837
	-500	7720	735	"	1484	735	-2757	1991		1045	-2253	"		1045
	-600	6546	748	"	1510	748	-2921	2026		1127	-2704	2189		1127

* $T_{S2} \left(\frac{53}{56} \frac{132}{90} \right)$

Signature	Date of Signature
KH	1 AUG 85

D-6

Signatures	Date of Signature	Date Understood


13,220
REV
1ST
2 LO
2 HI
3 LO
3 HI
TORQUE - 10 LBFT
HP
HYD H.P.
MOTOR
PUMP
"MOTOR" SPEED
INPUT & OUTPUT POWER
"PUMP" SPEED
OUTPUT TORQUE
HYDROSTATIC POWER
NOTE
(1) 100% EFFICIENCY ASSUMED - ESP HYDROSTATIC UNITS
(2) BASED ON ALLISON TORQ. & SPEED TABLE
"MOTOR" SPEED - RPM
"PUMP" SPEED - RPM
2000
0
-2000
1000
800
600
400
200
0
-500
0
500
1000
1500
2000
2500
3000
3500
OUTPUT SPEED - RPM
XHM & HP & TORQUE
650
1 JULY 65
K.KIRATA

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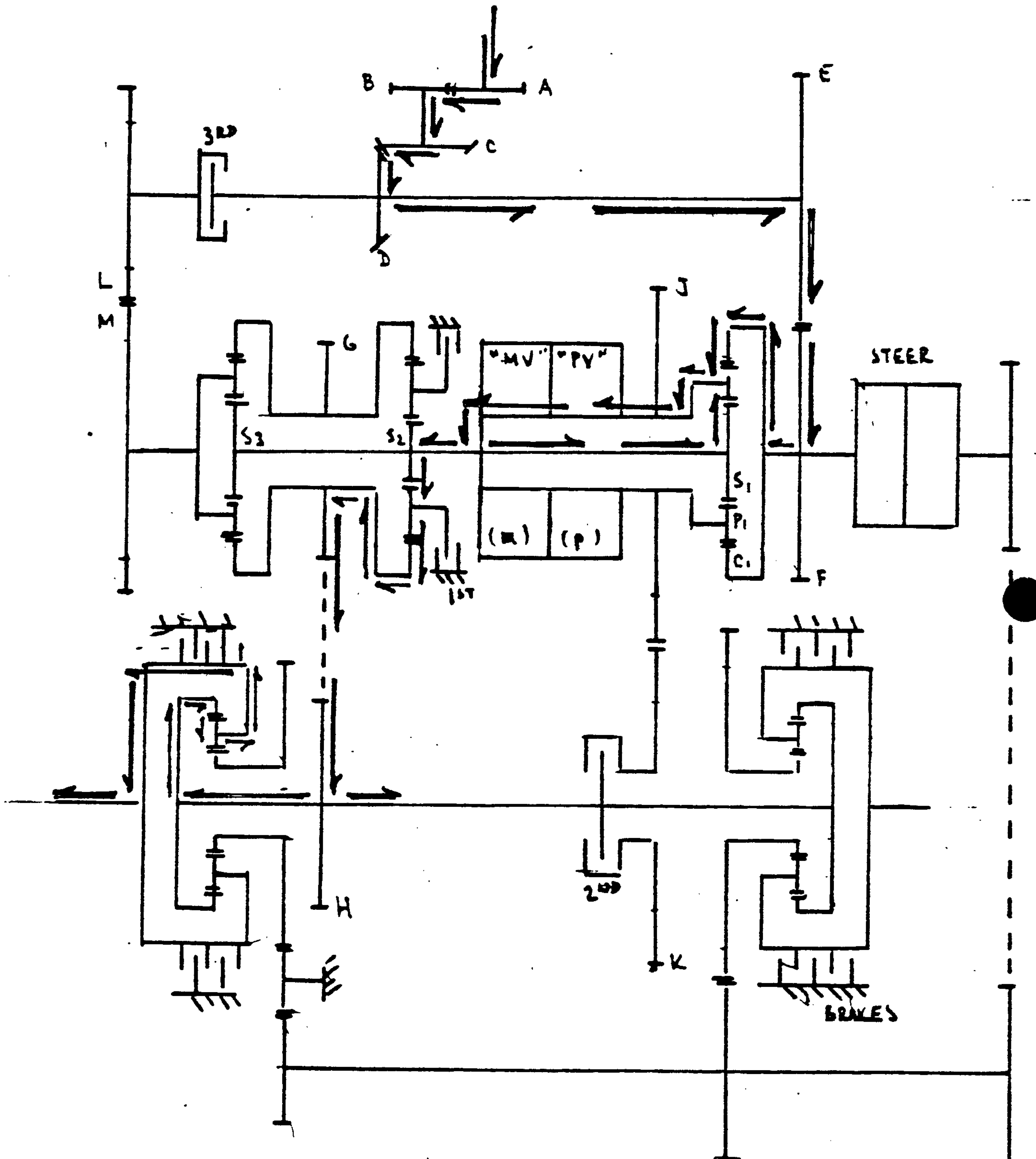
Page ___ of ___

Title: XHM 650 POWER FLOW – SCHEMATIC



REV

("MOTOR" SPD < 0)

( ) = ACTUAL HYDRAULIC FUNCTION

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	30 JULY 95				

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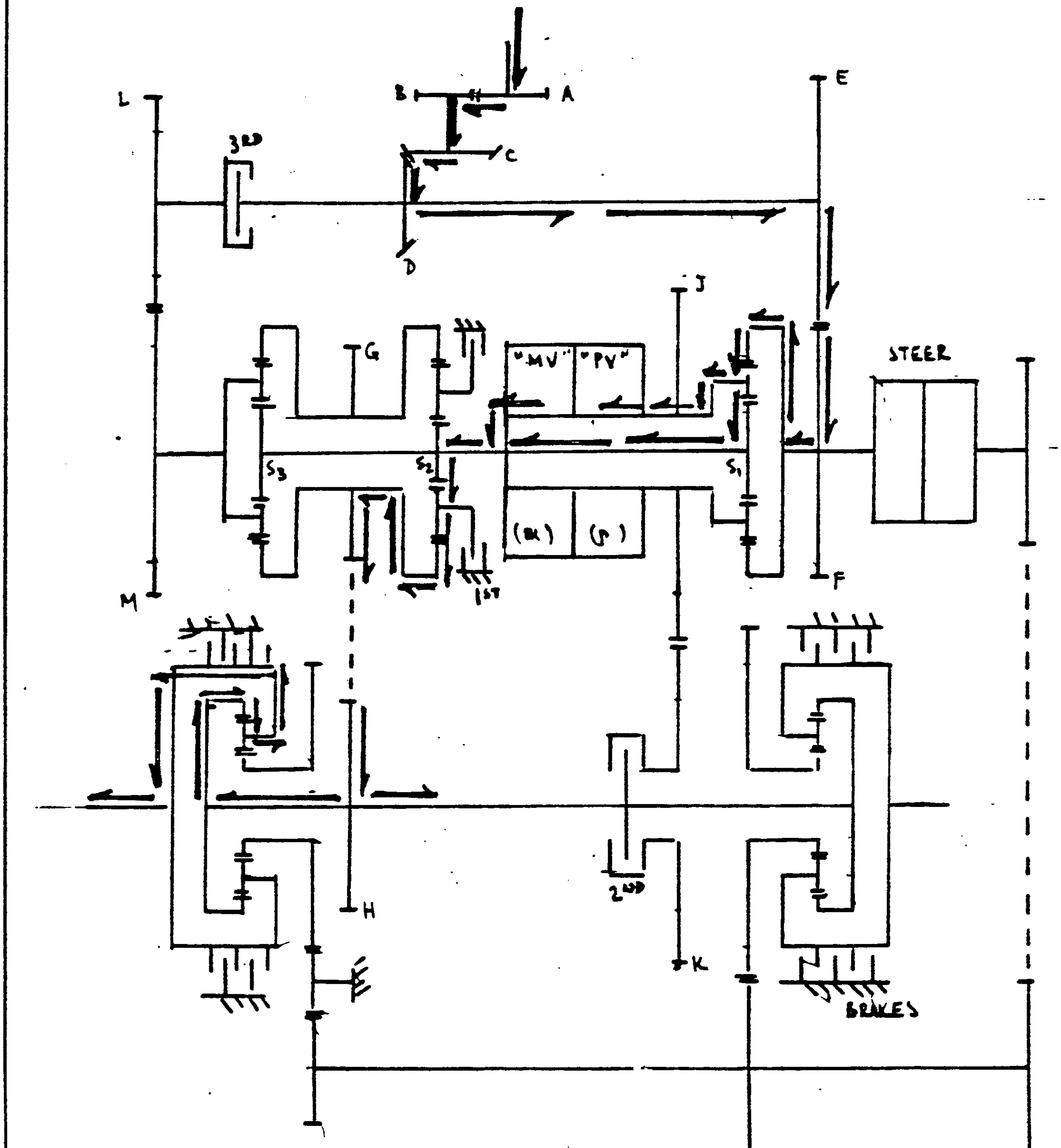
Title: XHM 650 POWER FLOW — SCHEMATIC



1ST
("MOTOR" SPD > 0)

( ) = ACTUAL HYDRAULIC FUNCTION

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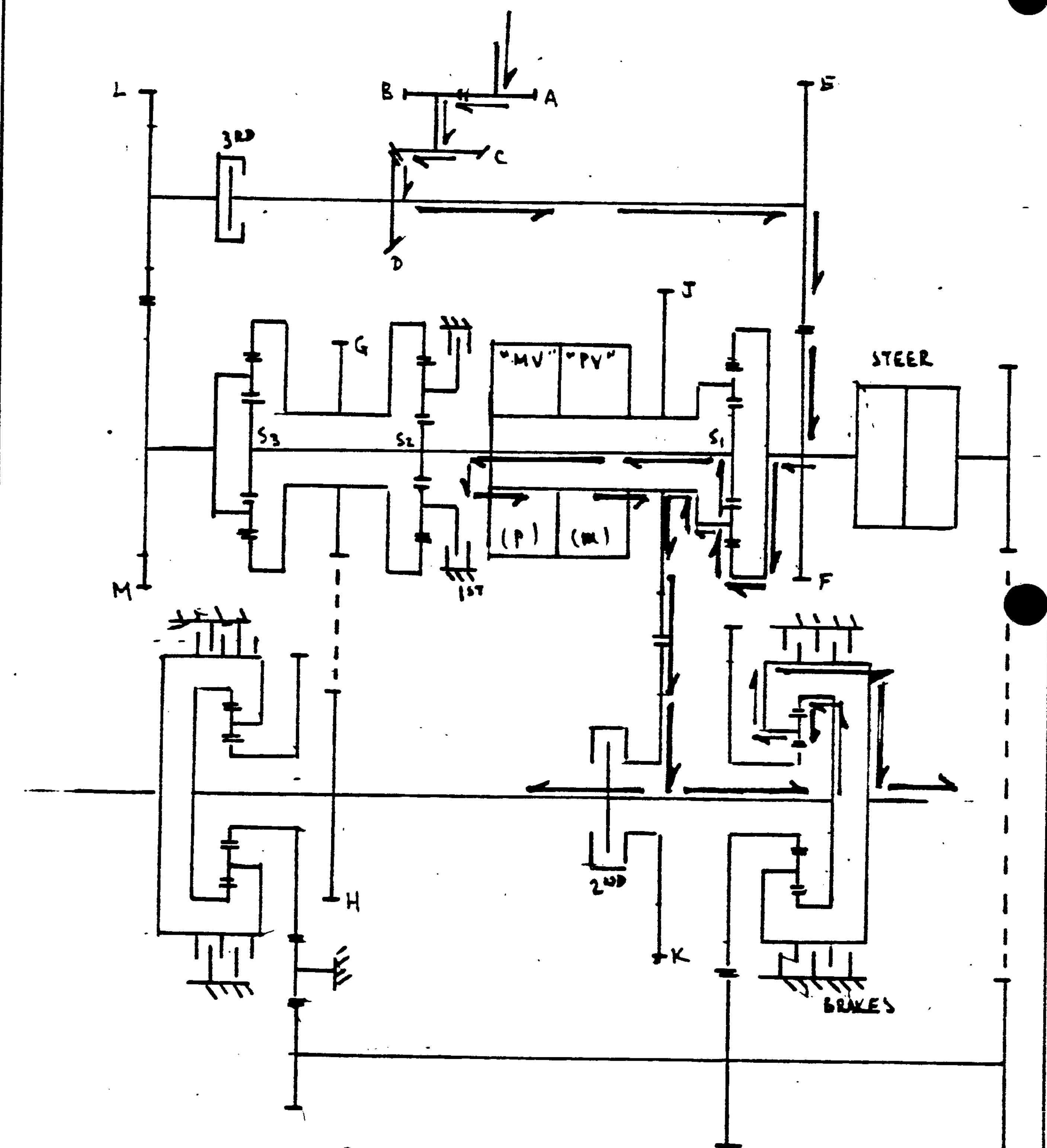
Title: XHM 650 POWER FLOW — SCHEMATIC



2 LO

("MOTOR" SPD > 0 BUT DECREASING)

( ) = ACTUAL HYDRAULIC FUNCTION

Signature	Date of Signature	Date of Conception	Witnesses Signatures	Date of Signature	Date Understood
[illegible]	30 July 85				

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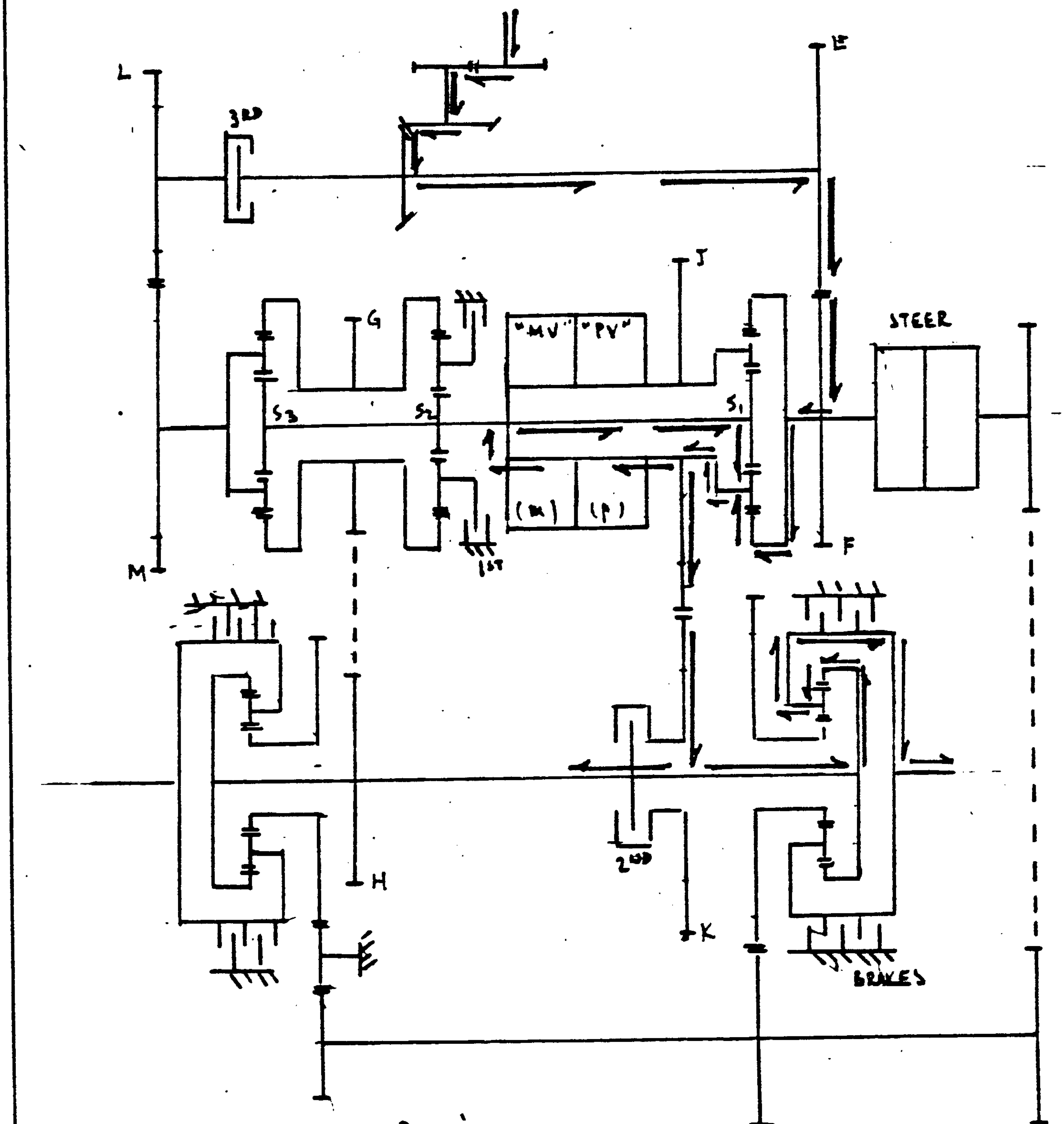
Project: ______

Page ___ of ___

Title: XHM 650 POWER FLOW — SCHEMATIC



2 HI

("MOTOR" SPD < 0 AND DECREASING)

( ) = ACTUAL HYDRAULIC FUNCTION

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[illegible]	30 JULY 85				

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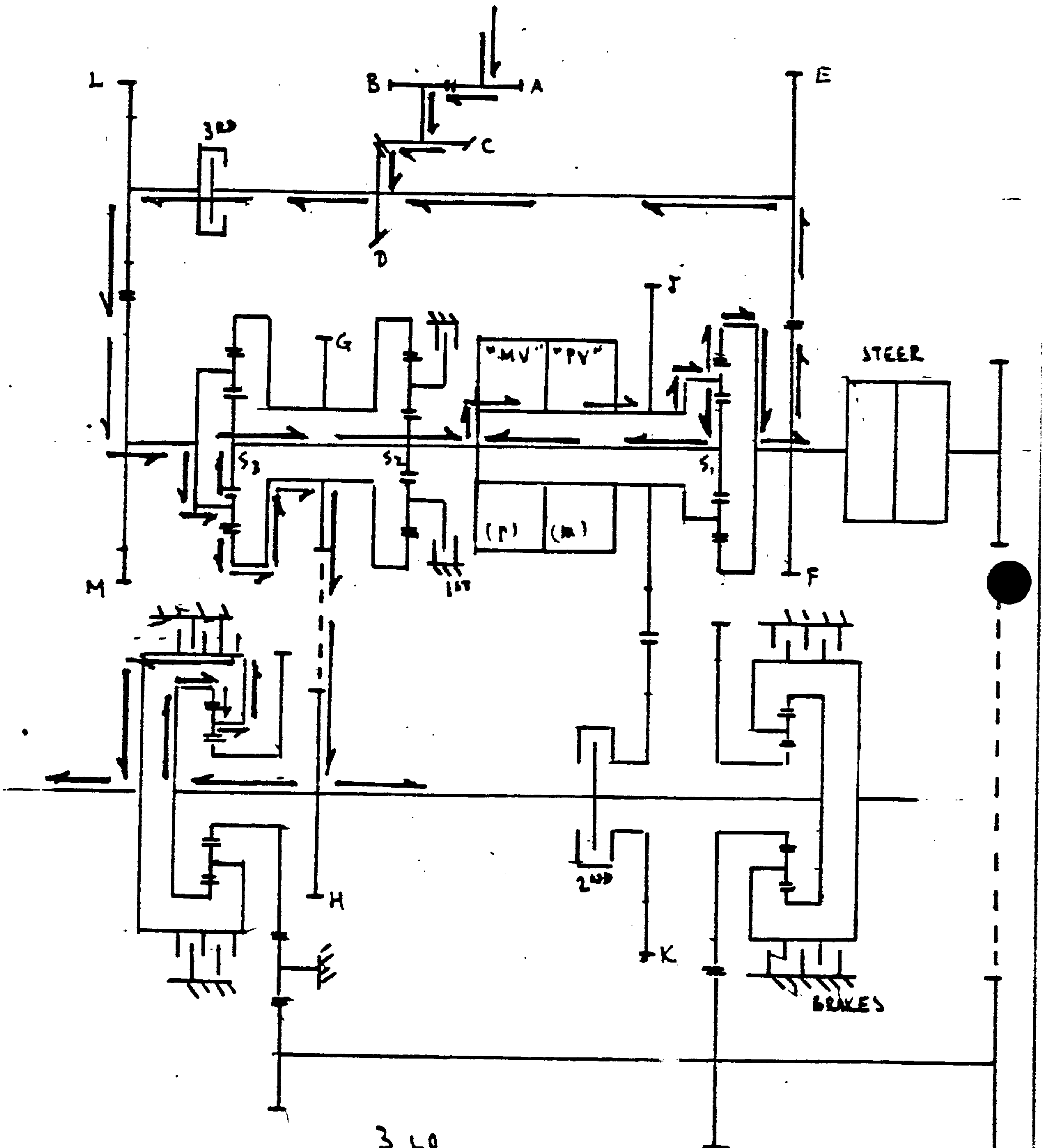
Title: XHM 650 POWER FLOW — SCHEMATIC



3 LO

("MOTOR" SPD < 0 BUT INCREASING)

( ) = ACTUAL HYDRAULIC FUNCTION

Signature	Date of Signature	Date of Conception	Witness Signature	Date of Signature	Date Understood
[illegible]	30 JULY 85				

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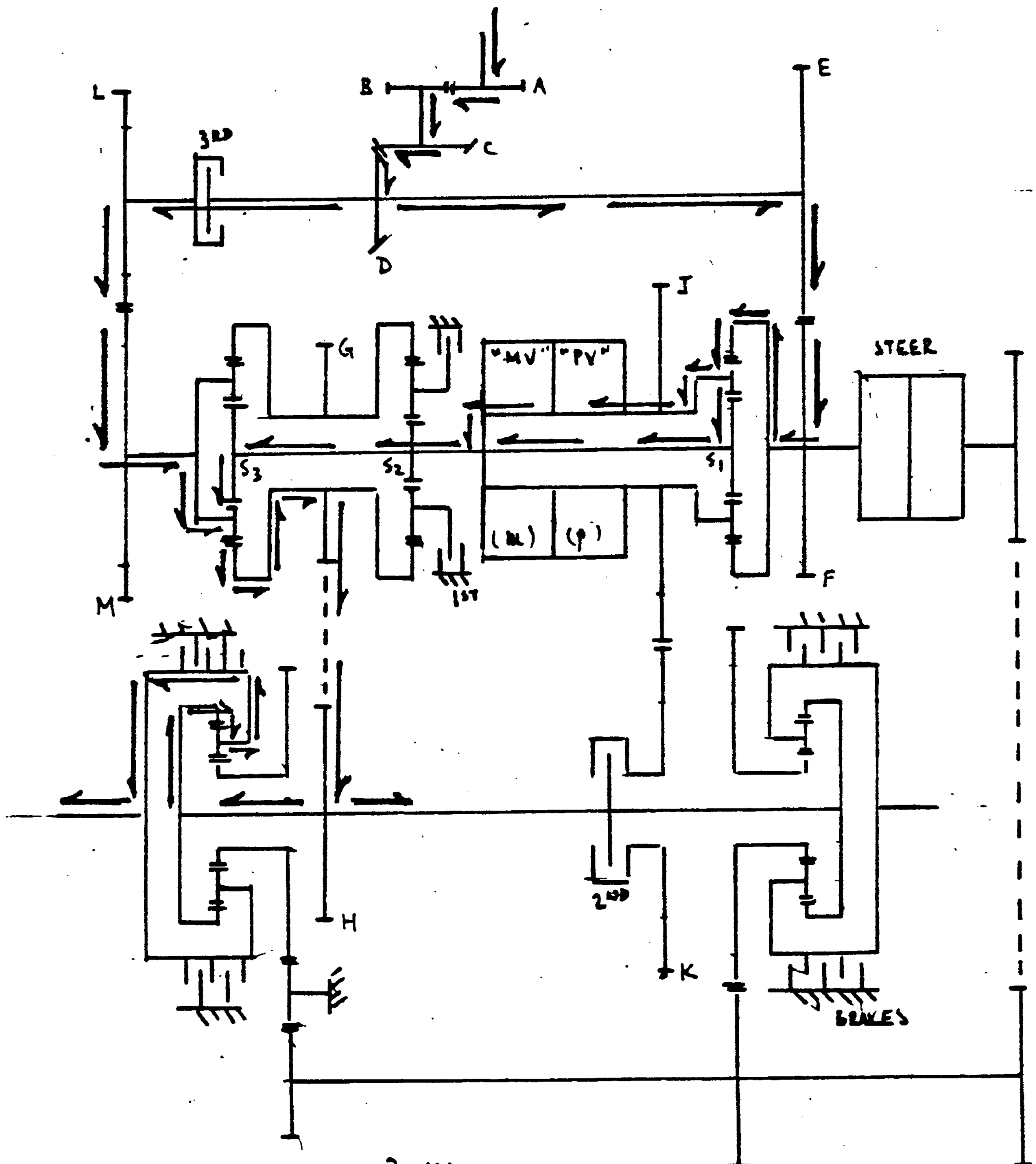
Title: XHM 650 POWER FLOW — SCHEMATIC



3 HI

("MOTOR" SPD > 0)

( ) = ACTUAL HYDRAULIC FUNCTION

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KL	30 JULY 85				

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Title: XHM 650 POWER FLOW

	2 HI (ωm ≤ 0 : DEC			3 LO (ωm < 0 : INC			3 HI (ωm > : INC		
	S_1	I_1	C_1	S_1	I_1	C_1	S_1	I_1	C_1
ω	−	−	−	−	−	−	+	−	−
T	−	−	+	+	+	−	−	−	+
HP	(+)	+	(−)	(−)	(−)	▲ +	(−)	(+)	■ −

				S_3	I_3	C_3	S_3	I_3	C_3
ω				−	−	−	+	−	−
T				+	+	−	+	+	−
HP				(−)	−	(+)	(+)	−	(+)

CHECK (FOR 2600 RPM INPUT)

	2 HI @ 1600 RPM OUT			3 LO @ 2000 RPM OUT			3 HI @ 3200 RPM OUT		
	S_1	I_1	C_1	S_1	I_1	C_1	S_1	I_1	C_1
ω	-1124.1	-3045.3	-2346.7	-722.4	-3045.3	-2200.6	2522.6	-3045.3	-1020.6
T	1.0	1.75	2.75	1.0	1.75	2.75	1.0	1.75	2.75
|Tω|	1124.1	5329.3	6453.3	722.4	5329.3	6051.7	2522.6	5329.3	2806.7

				S_3	I_3	C_3	S_3	I_3	C_3
ω				-722.4	-3090.5	-2229.4	2522.6	-4944.8	-2229.4
T				1.0	1.75	2.75	1.0	1.75	2.75
|Tω|				722.4	5408.3	6130.9	2522.6	8653.3	6130.9

▲ "PUMP" ACTS AS MOTOR, ■ "PUMP" ACTS AS PUMP

Signature KH Date of Signature 29 JULY 85

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Page 1 of 2

Title: XHM 650 POWER FLOW

GROUND RULES

INPUT HP = + OUTPUT HP = −

S & I HAVE SAME SIGN FOR TORK

(I) SENSE OF HP DERIVED FROM GROUND RULE

C WILL HAVE OPPOSITE SIGN

	REV			1ST (Wm > 0 & INC)			2 LO (Wm > 0 & DEC)		
	S_1	I_1	C_1	S_1	I_1	C_1	S_1	I_1	C_1
ω	−	−	−	+	−	−	+	−	−
T	−	−	+	−	−	+	−	−	+
HP	(+)	+	(−)	(−)	+	(−)	(−)	+	(−)

CHECK (FOR 2600 RPM INPUT)

	REV @ −608 RPM OUT			1ST @ 200 RPM OUT			2ND LO @ 1200 RPM OUT		
	S_1	I_1	C_1	S_1	I_1	C_1	S_1	I_1	C_1
ω	−2740.2	−3045.3	−2934.4	901.4	−3045.3	−1610.1	489.3	−3045.3	−1760.0
T ▼	1.0	1.75	2.75	1.0	1.75	2.75	1.0	1.75	2.75
|Tω|	2740.2	5329.3	8069.6	901.4	5329.3	4427.8	489.3	5329.3	4840.0

▼ ASSUMED

Signature [signature] | Date of Signature 29 JULY 85 | Date | Date of Signature | Date Understood

HMPT 500

SPEED ANALYSIS

FMC Corporation

@ 2600 RPM ENGINE

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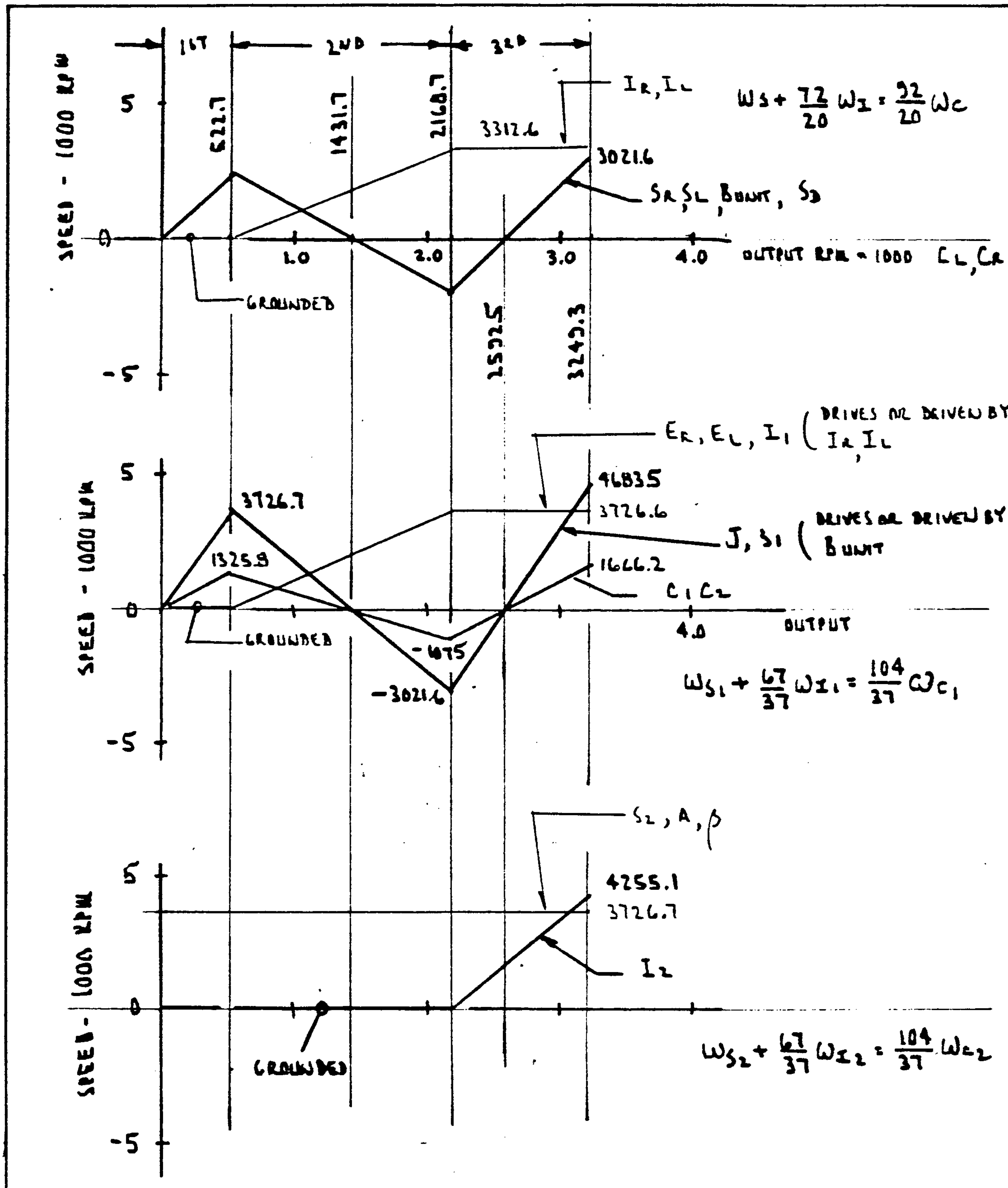
Title: GE HMPT 500 SPEED ANALYSIS



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Title: GE HMPT 500 SPD ANALYSIS

ω = ENGINE SPD = 2600 RPM CONSTANT

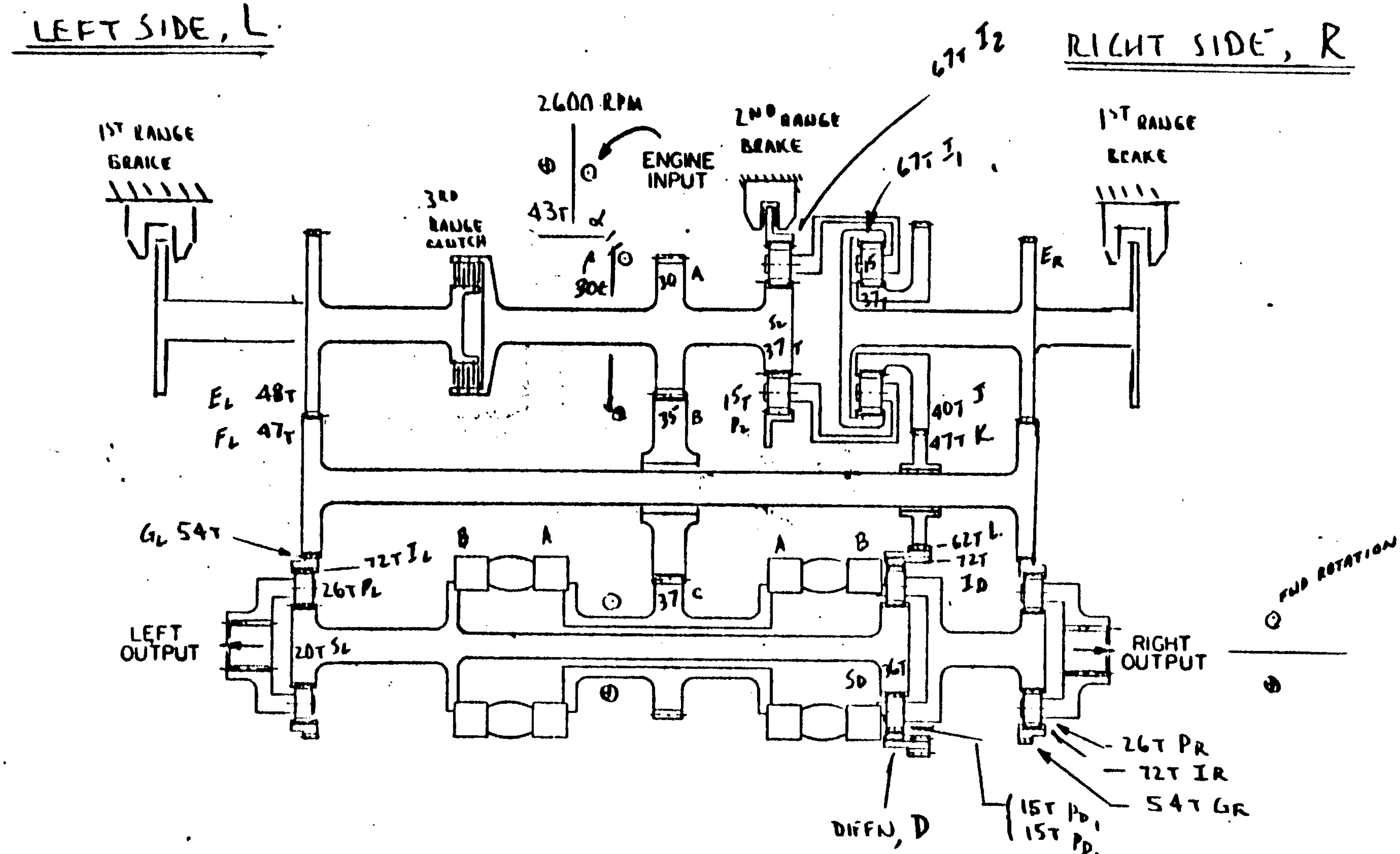
	1ST		2ND		3RD	
α	2600	2600	2600	2600	2600	2600
P & A	3726.7	3726.7	3726.7	3726.7	3726.7	3726.7
B	-3194.3	-3194.3	-3194.3	-3194.3	-3194.3	-3194.3
C (A unit)	3021.6	3021.6	3021.6	3021.6	3021.6	3021.6
B_L ! B_R / S_L S_R	0	2404.3	0	-1949.4	0	3021.6
C_L C_R	0	522.7	1431.7	2168.7	2592.5	3249.3
I_L I_R	0	0	1829.3	3312.6	3312.6	3312.6
C_D	0	2404.3	0	-1949.4	0	3021.6
I_D, L	"	"	"	"	"	"
S_D, S_L	"	"	"	"	"	"
L, I_D	"	"	"	"	"	"
K	0	-1581.5	0	1285.8	0	-1993.0
J, S_1	0	3726.7	0	-3021.6	0	4683.5
I_1	0	0	2058.0	3726.6	3726.7	3726.7
S_1, J	0	3726.7 ·	0	-3021.6	0	4683.5
C_1	0	1325.8 ·	0	-1075.0	0	1666.2
C_2	"	"	"	"	"	"
I_2	0	0	0	0	1668.7	4255.1
S_2, A, P	3726.7	3726.7	3726.7	3726.7	3726.7	3726.7
E_R E_L	0	0	2058.0	3726.6	3726.7	3726.7
F_R F_L	0	0	-2101.8	-3805.9	-3806.0	-3806.0
G_R G_L	0	0	1829.3	3312.6	3312.6	3312.6

BOUNT

OUT

Signature | Date of Signature

Signature | Date of Signature | Date Understood



MICV HYDROMECHANICAL TRANSMISSION

21 CIR HYDRAULIC PUMP/MOTORS.

GE HMPT 500 SPD ANALYSIS PG 3 OF 3

TYPICAL SPLIT

POWER FLOW RANGE

SECTION ANALYSIS

IV

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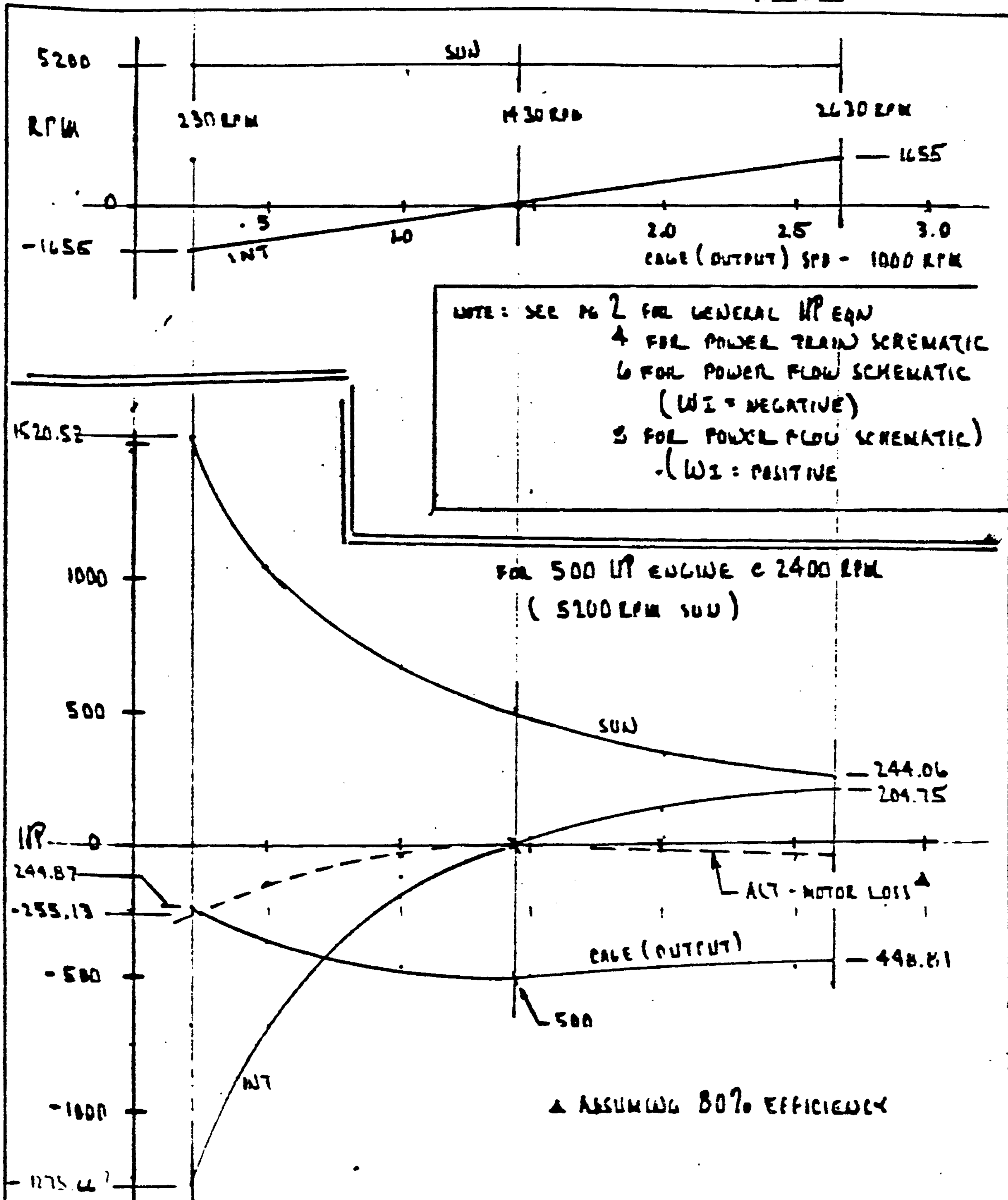
Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION



Signature	Date of Signature		Witness Signature	Date of Signature	Date Understood
V. HIRATA	17 Sep 84				

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Title: HP ANALYSIS – SPLIT POWER FLOW RANGE SECTION

SUMMARY OF HP EQNS

FOR ENGINE HP = 500

ALT - MOTOR EFF = 80%

$$m = \frac{\omega_I}{\omega_S} = 2.636$$

CASE I ω_I = NEGATIVE

$$T_S = \frac{500(5252)}{.8m\,\omega_I + \omega_S} \quad \text{LB FT}$$

$$HP_S = \frac{500(5252)}{.8m\,\omega_I + \omega_S} \cdot \frac{\omega_S}{5252} = 500\,\frac{\omega_S}{.8m\,\omega_I + \omega_S}$$

$$HP_I = \frac{m\,500(5252)}{.8m\,\omega_I + \omega_S} \cdot \frac{\omega_I}{5252} = 500\,\frac{m\,\omega_I}{.8m\,\omega_I + \omega_S}$$

$$HP_C = HP_{OUT} = \frac{500(5252)}{.8m\,\omega_I + \omega_S} \cdot \frac{\omega_S + m\,\omega_I}{5252} = 500\,\frac{\omega_S + m\,\omega_I}{.8m\,\omega_I + \omega_S}$$

$$HP_{LOSS} = .2\,HP_I = 100\,\frac{m\,\omega_I}{.8m\,\omega_I + \omega_S}$$

CASE II ω_I = POSITIVE

$$T_S = \frac{500(5252)}{1.25m\,\omega_I + \omega_S} \quad \text{LB FT}$$

$$HP_S = \frac{500(5252)}{1.25m\,\omega_I + \omega_S} \cdot \frac{\omega_S}{5252} = 500\,\frac{\omega_S}{1.25m\,\omega_I + \omega_S}$$

$$HP_I = \frac{500(5252)}{1.25m\,\omega_I + \omega_S} \cdot \frac{m\,\omega_I}{5252} = 500\,\frac{m\,\omega_I}{1.25m\,\omega_I + \omega_S}$$

$$HP_C = \frac{500(5252)}{1.25m\,\omega_I + \omega_S} \cdot \frac{\omega_S + m\,\omega_I}{5252} = 500\,\frac{\omega_S + m\,\omega_I}{1.25m\,\omega_I + \omega_S}$$

$$HP_{ALT} = \frac{HP_I}{.8}$$

$$HP_{LOSS} = .2\,HP_{ALT} = .25\,HP_I$$

Signature	Date of Signature	Date of Completion		Date of Signature	Date Understood

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Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION

CASE I - CONT

FOR Ws = 5200
CALCULATE HP @ Wc = 500 1000 & 1430

Wc	500	1000	1430	230.3
WI	-1283.00	-593.32	0	-1655
HPs	1042.33	658.43	500	1520.52
HPI	-677.92	-198.03	0	-1275.66
HPc	-364.42	-460.39	-500	-244.87
HPLoss	-135.58	-39.61	-0	-255.13

*.2HPI

CASE II - CONT
CALCULATE HP @ Wc = 1500 2000 & 2500

Wc	1500	2000	2500	2630
WI	96.36	786.04	1475.72	1655
HPs	471.23	333.76	258.39	244.06
HPI	23.02	132.99	193.25	204.75
HPc	-494.25	-466.75	-451.68	-448.81
HPLoss	-5.75	-33.25	-48.32	-51.19

*.25HPI

Signature Date of Signature 17 Sep 84

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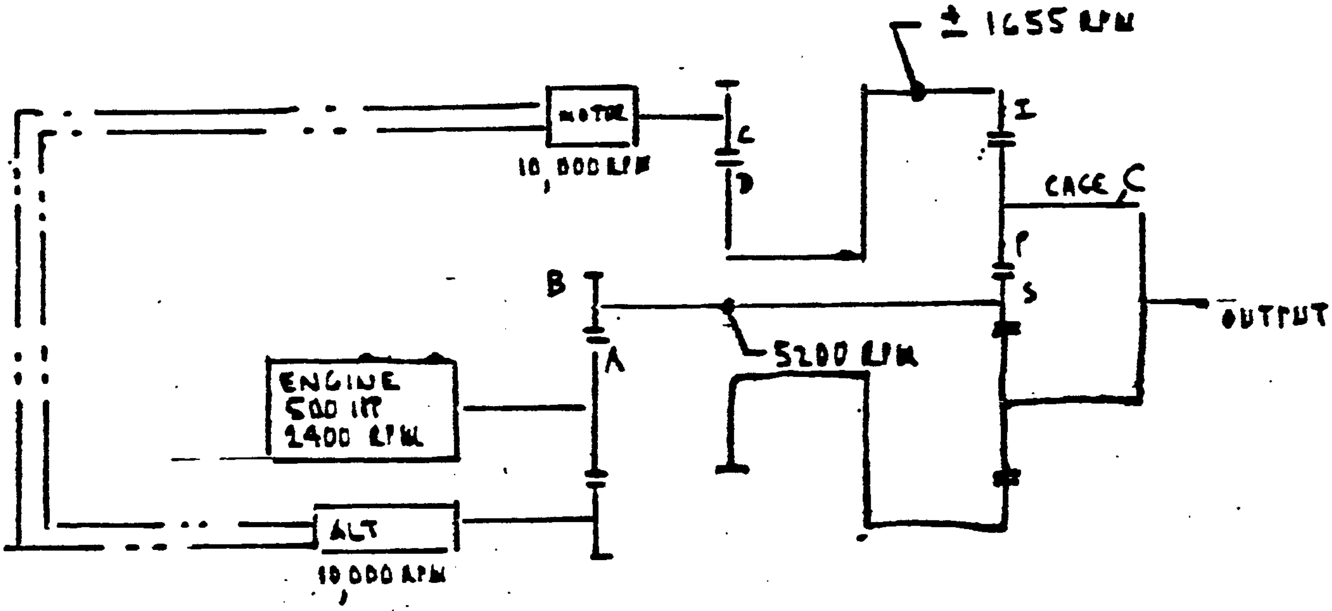
Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION



PROPOSED SPD CHANGE SECTION

$$\frac{N_B}{N_A} = \frac{1}{2.1667}$$

$$\frac{N_D}{N_C} = 6.0923$$

$$\frac{N_I}{N_S} = 2.636 \equiv m$$

OUTPUT SPEED, ω_c

$$\omega_c = \frac{\omega_s + m\,\omega_I}{1+m} = \frac{\omega_s + 2.636\,\omega_I}{3.636}$$

@ $\omega_s = 5200$, $\omega_I = -1655$

$$\omega_c = \frac{5200 + 2.636(-1655)}{3.636} = \underline{230.3 \text{ RPM}}$$

ω_c ($@\ \omega_I = -1655$)

@ $\omega_s = 5200$ $\quad \omega_I = 0$

$\omega_c = \underline{1430.1 \text{ RPM}}$

ω_c ($@\ \omega_I = 0$)

@ $\omega_s = 5200$ $\quad \omega_I = 1655$

$\omega_c = \underline{2630.0 \text{ RPM}}$

ω_c ($@\ \omega_I = 1655$)

Signature: [signature] | Date of Signature: 17 Sep 84 | Date | Signature | Date of Signature | Date Understood

FMC Corporation

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Project: ____
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Title: HP ANALYSIS – SPLIT POWER FLOW RANGE SECTION

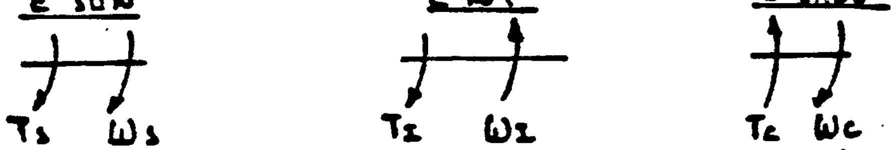
GROUND RULES FOR ANALYSIS OF HP & TORK

INPUT HP = + SIGN
OUTPUT HP = – SIGN

· SUN & INT TORK ARE SAME SENSE

CASE I $\omega_I = -$

@ SUN | @ INT | @ CAGE



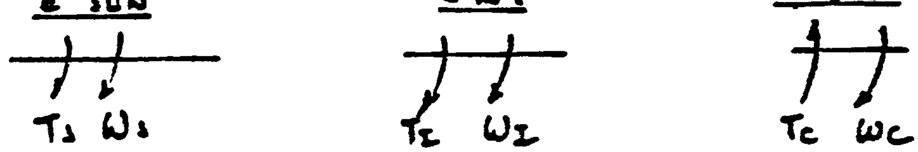
$\underbrace{T_s \quad \omega_s}$ + HP (INPUT)

$\underbrace{T_I \quad \omega_I}$ – HP (IE OUTPUT)

$\underbrace{T_c \quad \omega_c}$ – HP (IE OUTPUT)

CASE II $\omega_I = +$

@ SUN | @ INT | @ CAGE



T_s ω_s + HP (INPUT)

T_I ω_I + HP (INPUT)

T_c ω_c – HP (OUTPUT)

HP ANALYSIS – CASE I (ω_I = NEG)

Since HP_I is OUTPUT HP, THE SO CALLED MOTOR BECOMES AN ALT AND RECIRCULATES HP BACK INTO THE SUN.

ASSUME 80 % OVERALL EFF FOR THE ALT-MOTOR EFF — ALT-MOTOR EFF

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[illegible]	14 Sep 84				

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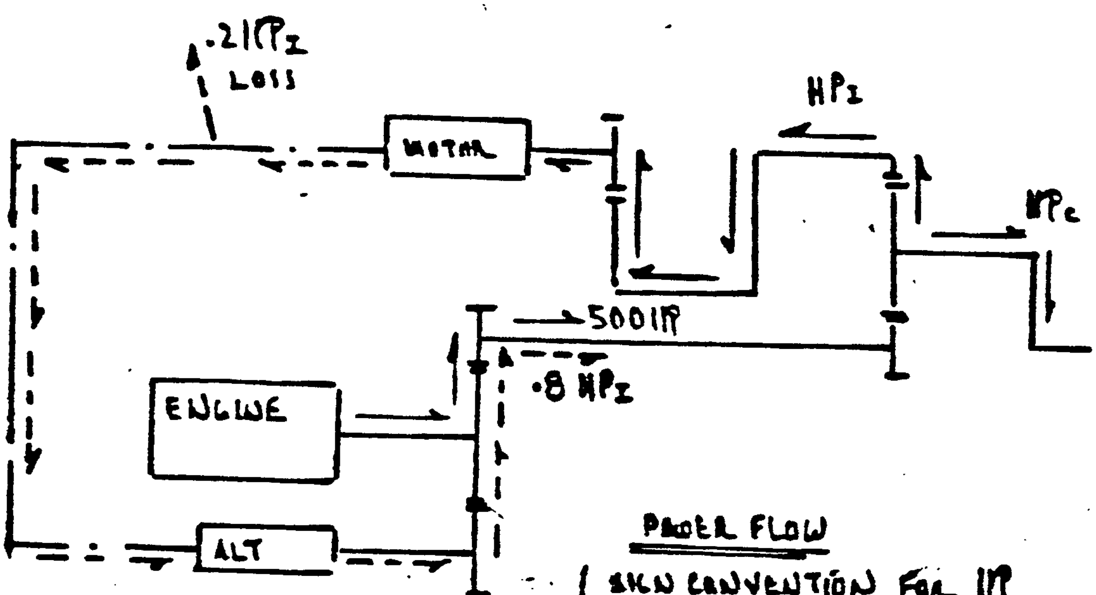
Title: HP ANALYSIS – SPLIT POWER FLOW RANGE SECTION

CASE I – HP ANALYSIS $\omega_I = NEG$



POWER FLOW
(SIGN CONVENTION FOR HP DISREGARDED

FOR THE OVERALL SYSTEM

$$500 + .2\,HP_I^{\blacktriangle} + HP_c^{\blacktriangle} = 0 \qquad \text{———} \quad (a)$$

▲ NOTE HP_I & HP_c ARE NEG.

FOR ω = RPM T = LB FT

$$\left.\begin{aligned} T_I &= \kappa T_s^{\bullet} \\ \omega_I &= \omega_I \end{aligned}\right\} \quad HP_I = \frac{\kappa T_s \omega_I}{5252} \qquad \text{———} \quad (b)$$

$$\left.\begin{aligned} T_c &= -(1+\kappa) T_s^{\blacktriangledown} \\ \omega_c &= \frac{\omega_s + \kappa \omega_I}{1+\kappa} \end{aligned}\right\} \quad HP_c = -\frac{T_s(\omega_s + \kappa \omega_I)}{5252} \qquad \text{———} \quad (c)$$

▼ CAGE TORK IS OPPOSITE TO SUN & INT

SUBSTITUTING (b) & (c) INTO (a)

$$500 + \frac{.2\kappa T_s \omega_I}{5252} - \frac{T_s(\omega_s + \kappa \omega_I)}{5252} = 0$$

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	10 Sep 84			

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Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION

CASE I

$$500 + \frac{T_S}{5252}\left[.2n\omega_Z - \omega_S - n\omega_Z\right] = 0$$

$$T_S = \frac{500\,(5252)}{.8n\,\omega_Z + \omega_S}$$

GENERAL T_S EQN

FOR $\omega_S = 5200$ $\omega_Z = -1655$; $n = 2.636$

$T_S = 1535.73$ LB FT

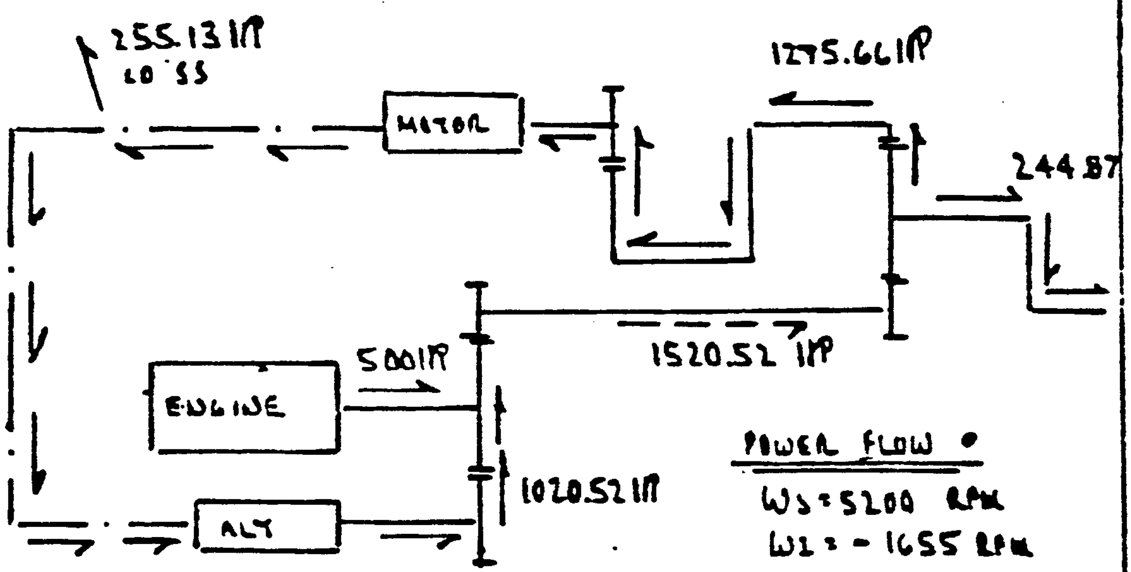
$\therefore$ $HP_S = 1520.52$

$HP_Z = -1275.66$

$.8\,HP_Z = 1020.52$

$.2\,HP_Z = -255.13$

$HP_C = -244.87$



POWER FLOW

$\omega_S = 5200$ RPM

$\omega_Z = -1655$ RPM

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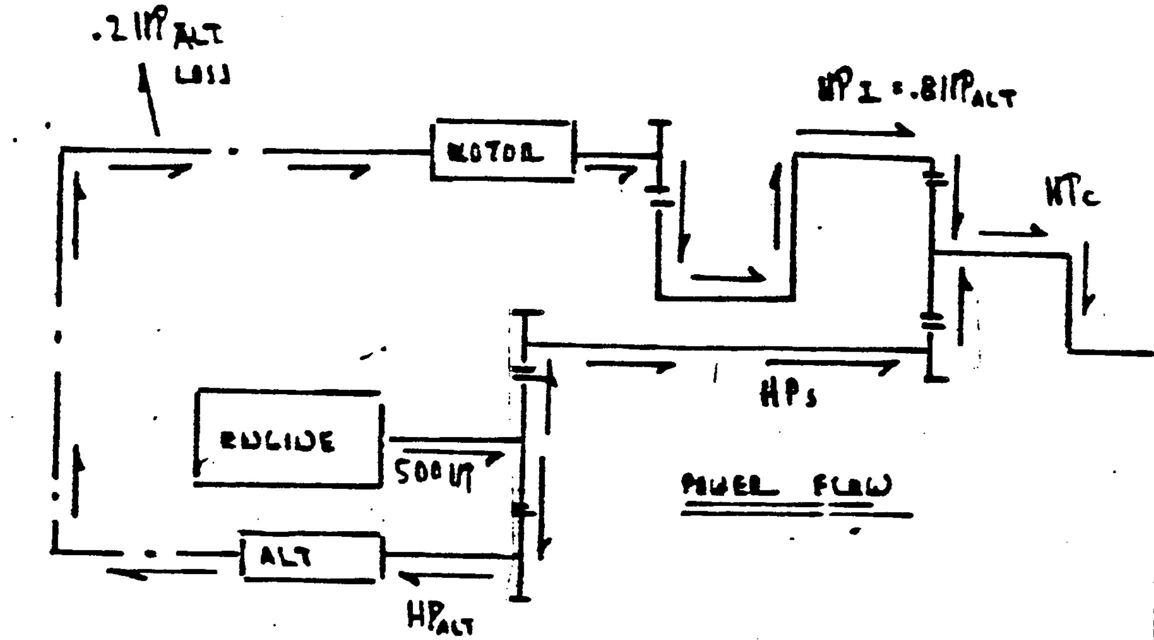
Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION

CASE II HP ANALYSIS ω_I = POSITIVE



$$500 - .2\,HP_{ALT} + HP_c = 0$$

or $$500 - .25\,HP_I + HP_c = 0 \qquad \text{(a)}$$

But $$HP_I = \frac{m\,T_s\,\omega_I}{5252} \qquad \text{(b)}$$

$$HP_c = \frac{-T_s(\omega_s + m\,\omega_I)}{5252} \qquad \text{(c)}$$

Substituting (b) & (c) into (a)

$$500 - \frac{.25\,m\,T_s\,\omega_I}{5252} - \frac{T_s(\omega_s + m\,\omega_I)}{5252} = 0$$

$$500 - \frac{T_s}{5252}\left[-.25\,m\,\omega_I - \omega_s - m\,\omega_I\right] = 0$$

$$T_s = \frac{500(5252)}{1.25\,m\,\omega_I + \omega_s}$$

GENERAL T_s EQN

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Title: HP ANALYSIS - SPLIT POWER FLOW RANGE SECTION

CASE II CONT

FOR $\omega_S = 5200$; $\omega_I = 1655$

$T_S = 246.50$ LB FT

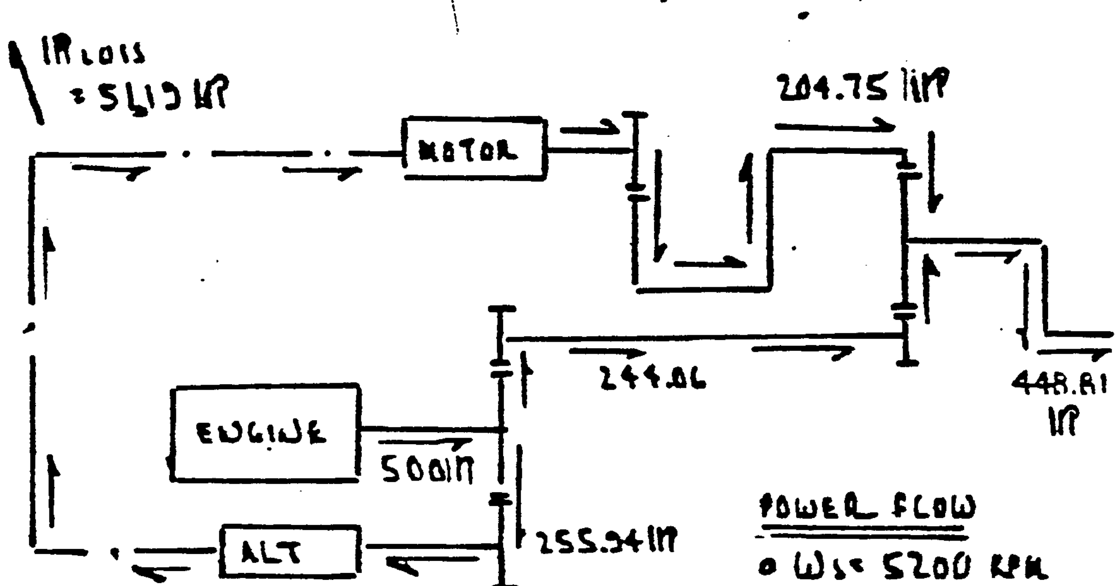
$\therefore HP_S = 244.06$

$HP_I = 204.75$

$HP_{ALT} = 255.94$

$HP_C = -448.81$

$.2\,HP_{ALT} = 51.19 = HP_{LOSS}$



POWER FLOW

@ $\omega_S = 5200$ RPM

$\omega_I = 1655$ RPM

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Date of Signature | Date Understood

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APPENDIX E

ELECTRIC VEHICLE PERFORMANCE SIMULATION

Appendix E Electric Vehicle Performance Simulation

E.1 Major Program Capabilities

Electrically driven, tracked vehicle-performance is simulated by this software package. Parameters which may be investigated include detailed electrical system performance, vehicle track dynamics, system losses and efficiency, incremental and average gross vehicle dynamics, and fuel economy. There are four subprograms which have been created to specifically consider each of these areas in detail. A brief description of each is given below.

E.1.1 Constituent Subprograms

o Electric Drive Performance - Steady-state vehicle powertrain analysis with detailed emphasis on electric power drive parameters. Electric motor voltages, currents, generated power and alternator/generator output are calculated, along with energy usage, heat rejection, and fuel use impact.

o Vehicle Acceleration Performance - Analysis of dynamic vehicle performance which realistically simulates the gross vehicle mission over the terrain conditions. Acceleration, deceleration, braking, and constant velocity conditions are considered.

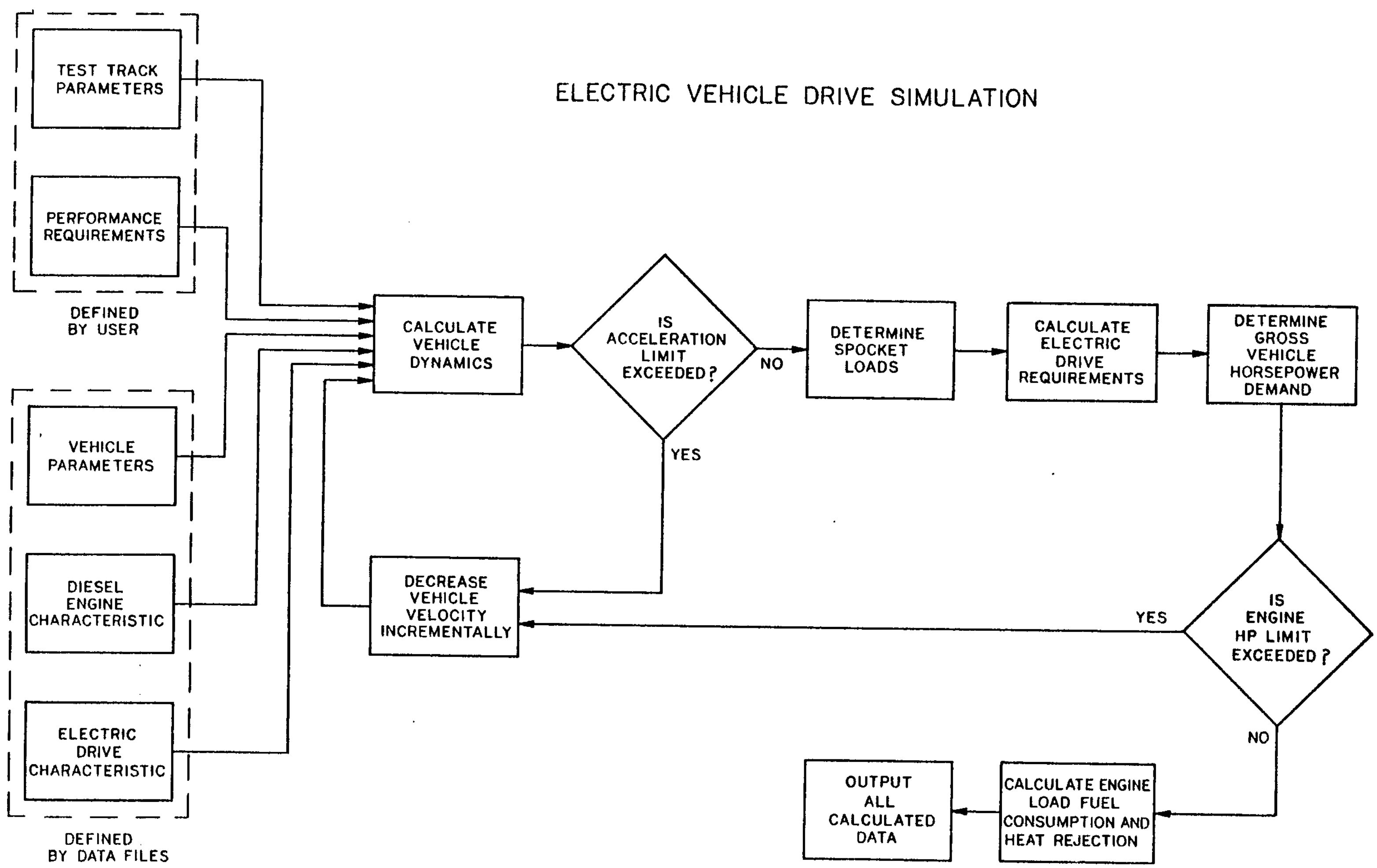
o Acceleration Dynamics Routine - Detailed analysis of full power acceleration during turning and nonturning maneuvers on user defined grades and surfaces. Incremental dynamic parameters are generated and tabulated.

o Reduction Dynamics Routine - Detailed analysis of speed/torque loading of all vehicle power train reduction elements. Final sprocket drives and prime mover interface reductions are included in the analysis.

Of four subprograms provided, the first two are perhaps the most useful for the consideration of the vehicle electric drive and the impact that it has on the overall vehicle mission. The latter two routines are best utilized for detailed investigation of those processes which help to make up the overall mission, but are not the parameters of major interest from a mission viewpoint. For this reason all further discussion will focus on the performance subprograms.

E.1.2 Performance Model Description

Each of the performance subprograms outlined above rely on an iterative energy balance technique to yield each steady-state operating point of the vehicle. The basic algorithm for this strategy is shown in Figure E.1.2-1. Test track parameters and



ELECTRIC VEHICLE DRIVE SIMULATION
TEST TRACK PARAMETERS
PERFORMANCE REQUIREMENTS
DEFINED BY USER
VEHICLE PARAMETERS
DIESEL ENGINE CHARACTERISTIC
ELECTRIC DRIVE CHARACTERISTIC
DEFINED BY DATA FILES
CALCULATE VEHICLE DYNAMICS
IS ACCELERATION LIMIT EXCEEDED?
NO
YES
DETERMINE SPOCKET LOADS
CALCULATE ELECTRIC DRIVE REQUIREMENTS
DETERMINE GROSS VEHICLE HORSEPOWER DEMAND
DECREASE VEHICLE VELOCITY INCREMENTALLY
IS ENGINE HP LIMIT EXCEEDED?
YES
NO
CALCULATE ENGINE LOAD FUEL CONSUMPTION AND HEAT REJECTION
OUTPUT ALL CALCULATED DATA

performance requirements are defined and input by the user, along with vehicle, engine, and electric drive data which are resident within the program's data files. The vehicle dynamics are then calculated utilizing a Merritt's track model which considers the track dynamics based on empirical data. A centrifugal acceleration calculation is then performed to determine if any set acceleration limit is exceeded, such as personnel restrictions or vehicle track slip (surface coefficient or friction). If exceeded, the vehicle velocity is reduced and the process iterates until the acceleration falls within the selected bounds. The sprocket loads which have been calculated are used to determine what the electrical requirements are for each of the sprocket motors. This data is reflected back through the electrical system, ultimately to the prime mover, where the gross vehicle horsepower demand is calculated. At this point the energy balance is tested. If the fixed maximum output power of the prime mover is adequate for the present demand, the resultant system heat rejection and fuel consumption are calculated. If the system demands exceed the capabilities of the engine, the vehicle load is reduced by lowering the velocity until an energy balance is achieved. When this has been accomplished, either the calculated data is output to the user, as in the Electric Drive Performance subprogram, or it is further utilized in an acceleration or deceleration routine as in the Vehicle Acceleration Performance subprogram.

E.2 Program Options Available

The following six basic categories represent the various options which are available to the user from the program data files. Certain of the parameters must be defined by the user, such as the performance limitations which are addressed below.

E.2.1 Test Courses

There are four resident test courses provided within the software package. Each is broken down into segments of defined length, grade, and turn radius.

o MERADCOM Test Course - This course consists of a well defined track which is located in the Aberdeen Proving Ground, Maryland. Sixteen segments make up the track, which has a total circumference of 2.5 miles.

o Speed on Slope - A track consisting of thirteen segments of arbitrary length (1000 ft) was fabricated to aid in the derivation of the contractually required speed on slope curve. Grades from +60 percent to -60 percent are provided with intermediate grade points selected every 5 percent.

o Tractive Effort vs. Speed - This test track is set up with grade values which yield a relatively uniform distribution of tractive effort values (TE) when plotted against speed.

o Churchville Test Course - This test course is the most rigorous and complex provided in the software package. Highly detailed topographical maps of the Churchville area (part of Aberdeen Proving Grounds) were used extensively in the definition of this track, which is comprised of 88 segments. Steep grades, sharp curves, and short segments serve to make this a very demanding and useful evaluator of vehicle performance. The course, which is 3.33 miles in length, is shown in topographic form in figure E.2.1-1, and in elevation in Figure E.2.1-2.

E.2.2 Course Surface

To provide greater flexibility in the number of options available to the user, the surface coefficient of friction (μ) is selected apart from the physical dimensions of each course. Those available are given below:

- o Concrete/Asphalt, μ = 0.80 (MERADCOM)
- o Compacted Soil, μ = 0.70 (Churchville)
- o Loose Sand, μ = 0.55
- o Rocky Terrain, μ = 0.45
- o User Defined

E.2.2 Vehicle/Engine

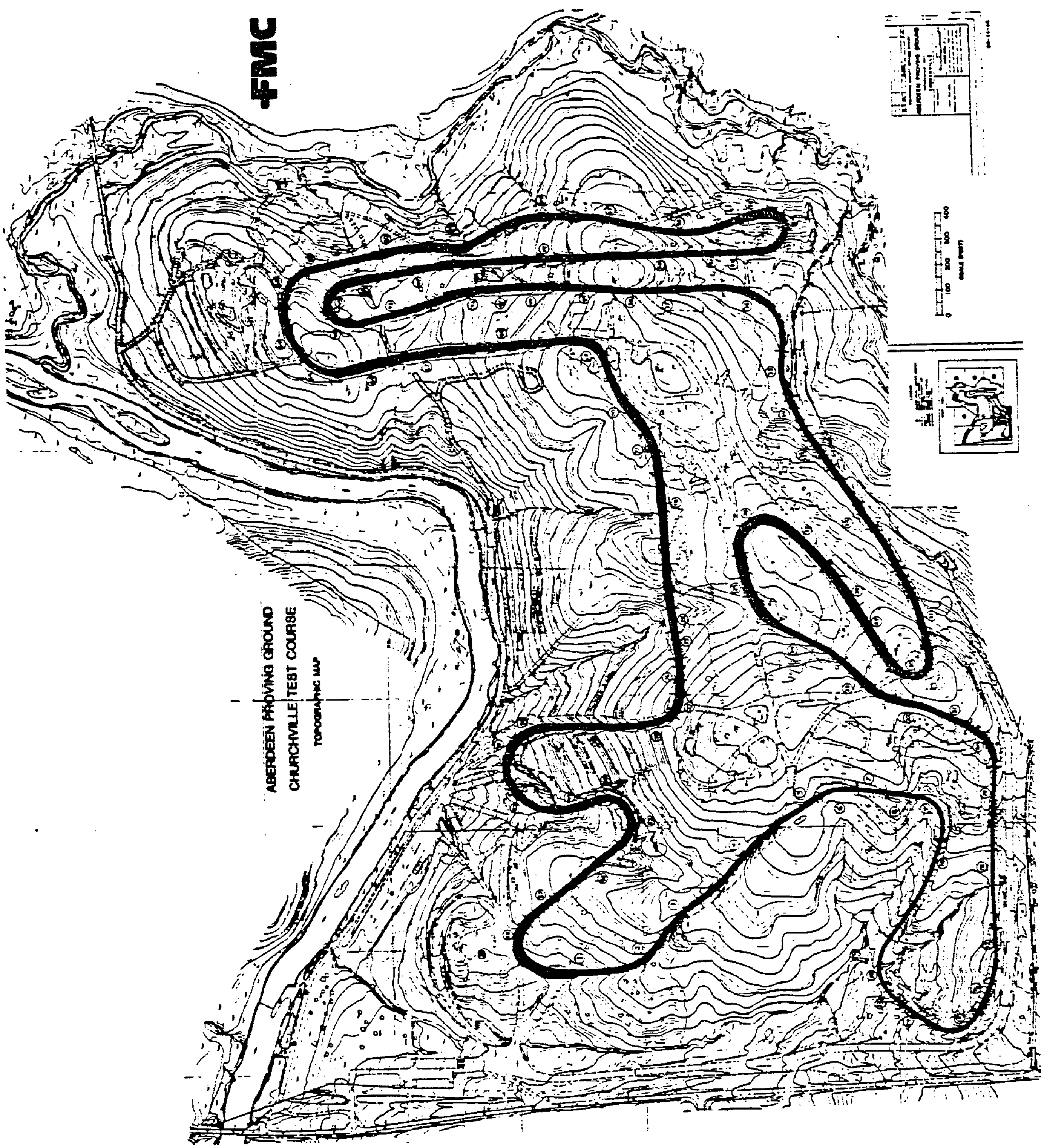
Both the 19.5 and 40.0 ton TACOM specified tracked vehicles are resident within the software package, as well as the specified engines (Cummins VTA-903 for the 19.5 ton, and the AD-1000 for the 40.0 ton). The option is also given to the user to define the parameters of their own tracked vehicle.

E.2.4 Engine Scheduling

Both constant and variable diesel engine scheduling is available to the user to aid the determination of which is more fuel efficient. Each technique utilizes fuel consumption curves for the VTA-903, and the AD-1000. With constant scheduling, fuel consumption is based on a relationship which is only dependent on demanded HP, whereas with variable scheduling, the demanded HP defines the engine speed which then yields the appropriate fuel consumption.

E.2.5 Electric Drive Type

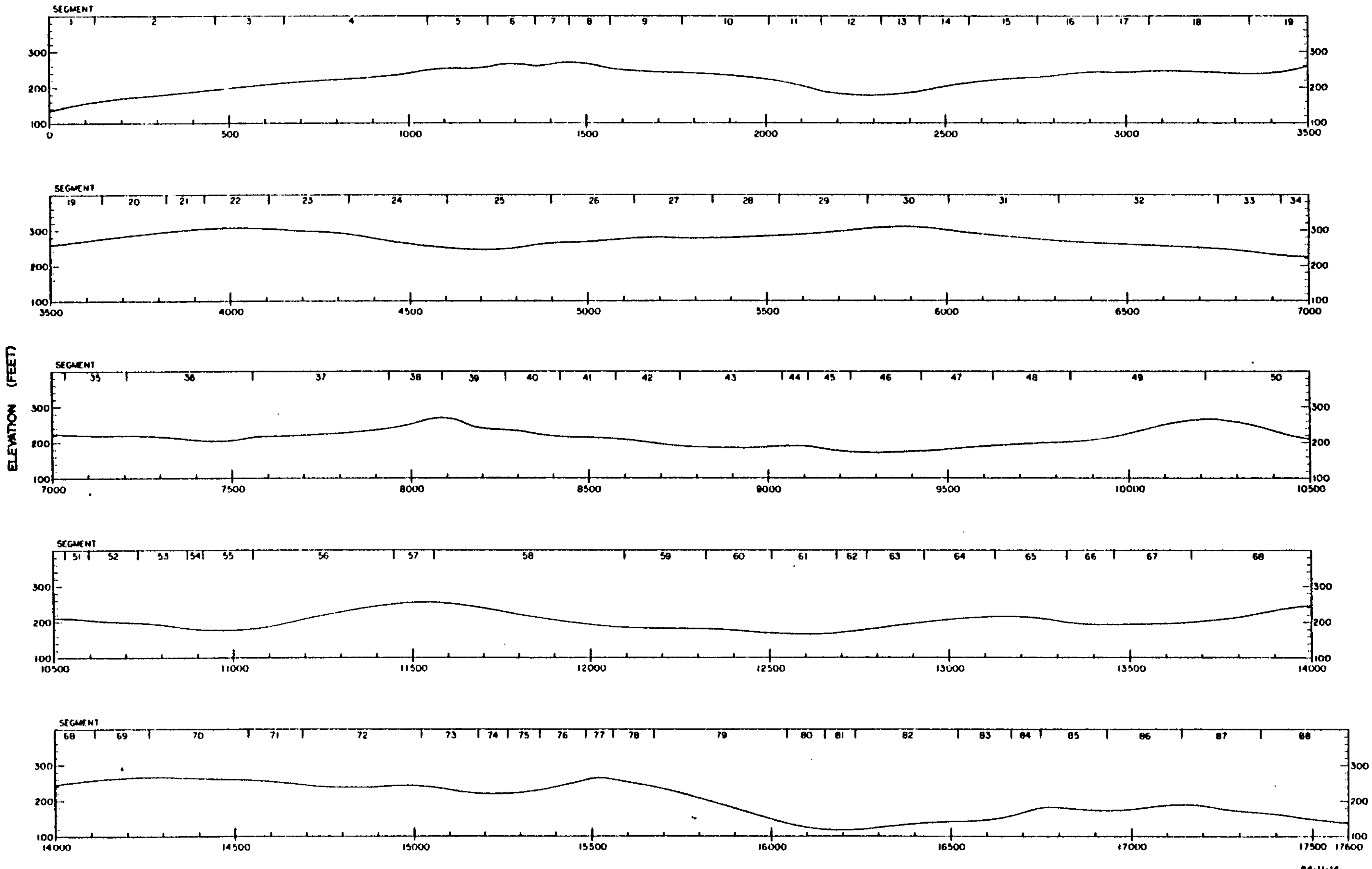
The are eight electric drive types which are resident within the software package. The entire electric propulsion system is


FMC
ABERDEEN PROVING GROUND
CHURCHVILLE TEST COURSE
TOPOGRAPHIC MAP

ABERDEEN PROVING GROUNDS

CHURCHVILLE TEST COURSE

ELEVATION VIEW



COURSE DISTANCE (FEET)

COUNTER-CLOCKWISE TRAVERSAL

defined for each.

- o Homopolar, Generator Driven (parallel/series systems)
- o Homopolar, Alternator Driven (parallel/series systems)
- o Brushless DC, Alternator Driven (low speed-high torque/high speed-low torque)
- o High Frequency Induction, Alternator Driven
- o Commutated DC, Alternator Driven

E.2.6 Performance Limitation

Several inputs not available for the internal data files are required of the user. These include:

- o Maximum (final) Forward Velocity
- o Maximum Forward Acceleration
- o Maximum Deceleration
- o Maximum Lateral Acceleration

E.3 Vehicle Mission Simulation and Analysis

E.3.1 Electric Drive Performance

The emphasis of this subprogram is the steady state analysis of electrically driven vehicles on a segment by segment basis as the vehicle maneuvers over a given course. It is best suited for analysis of steady state electric drive mission performance, particularly if the course of the mission is relatively uniform, and the segments of each course segment are lengthy in comparison to the time it takes the vehicle to traverse them. Detailed sprocket data (see Figure E.4-2) for each track is available to the user, as well as the equivalent sprocket motor dynamics. Motor and system electrical data is also generated, including voltages, currents, and power, including the net power which must be supplied (or absorbed) to both sprocket motors from the bus. These parameters aid in the evaluation of the system operation during turns and regenerative conditions, and allow the magnitudes and directions of system energy flow to be easily monitored. Net drive efficiency along with generated and lost energy are also provided to determine if overall system performance is within acceptable limits. These energies are reflected in terms of required prime mover power and the resultant fuel consumption. For further mission analysis, fuel economy is calculated, and a range estimate based on a specified vehicle fuel tank volume is made.

E.3.2 Vehicle Acceleration Performance

For any vehicle mission, this subprogram provides the user with the most realistic assessment of vehicle performance over any course conditions. All vehicle transitory states (i.e., acceleration, deceleration, braking) between constant velocity conditions are considered in order to yield smooth vehicle motion throughout the course. The subprogram is specified for overall mission analysis rather than an electric drive component evaluation. This is evident in the printed output page (see Figure E.4-3) which provides detailed acceleration/deceleration information, but no internal electric drive data. The complete electric drive models are utilized for this analysis but the transitory nature of the vehicle drive during the test periods makes it difficult to extract any meaningful output of the electrical parameters.

As with the Electric Drive Performance subprogram, power supplied by the prime mover is determined along with the system energy which is generated and lost. Fuel consumption data is presented as well as the full fuel tank range estimate. Cumulative mission information is available for each segment of the course, and can provide a useful means of evaluating incremental mission performance.

E.4 Program Outputs

Examples of the information which each of the subprograms outputs to the user are given in Figures E.4-2 to E.4-5. Figure E.4-1 is the main program header sheet that is included with each run to specify which subprogram is in use and which echoes all the data that has been input by the user.

ELECTRIC VEHICLE MISSION SIMULATION

FMC / NORTHERN ORDNANCE DIVISION
MINNEAPOLIS, MINNESOTA USA

REVISION DATE: 12/10/84
RUN DATE: 5/21/85

ELECTRICALLY DRIVEN, TRACKED VEHICLE PERFORMANCE IS SIMULATED BY THIS PROGRAM. DETAILED ASPECTS OF VEHICLE PERFORMANCE CAN BE INVESTIGATED USING THE FOUR RESIDENT SUB-PROGRAMS LISTED BELOW. THE SUB-PROGRAM IN USE IS IDENTIFIED WITH AN ASTERISK.

* 1.) ELECTRIC DRIVE PERFORMANCE - STEADY STATE VEHICLE PERFORMANCE ANALYSIS WITH DETAILED EMPHASIS ON ELECTRIC POWER DRIVE PARAMETERS. ENERGY USAGE, HEAT REJECTION, AND FUEL IMPACT ARE ALSO CALCULATED.

2.) VEHICLE ACCELERATION PERFORMANCE - DYNAMIC VEHICLE PERFORMANCE ANALYSIS WHICH REALISTICALLY SIMULATES GROSS VEHICLE MISSION OVER ALL TERRAIN CONDITIONS. ACCELERATION, DECELERATION, BRAKING AND CONSTANT VELOCITY CONDITIONS ARE CONSIDERED.

3.) ACCELERATION DYNAMICS ROUTINE - DETAILED ANALYSIS OF FULL POWER VEHICLE ACCELERATION DURING TURNING AND NON-TURNING MANEUVERS ON USER SELECTED GRADES AND SURFACES. INCREMENTAL DYNAMIC PARAMETERS ARE GENERATED AND TABULATED.

4.) REDUCTION DYNAMICS ROUTINE - DETAILED ANALYSIS OF SPEED/TORQUE LOADING OF ALL VEHICLE POWER TRAIN REDUCTION ELEMENTS. FINAL SPROCKET DRIVES AND DIESEL ENGINE INTERFACE ARE INCLUDED IN ANALYSIS.

COURSE DATA	VEHICLE DATA	ENGINE DATA	ELECTRIC DRIVE DATA
COURSE: CHURCHVILLE	GROSS VEHICLE WEIGHT, tons= 19.5	ENGINE: VTA-903	TYPE: HoPol P-A
SURFACE: COMPACTED SOIL	FRONTAL AREA, sq. ft.= 57	MAX. POWER, hp= 500	PEAK MOTOR EFF., %= 90
COEFFICIENT OF FRICTION= .7	COEFFICIENT OF DRAG= 1	MAX. SPEED, rpm= 2960	ALTERNATOR EFF., %= 90
PERFORMANCE LIMITS	TREAD WIDTH, in.= 92.5	SPEED FOR MIN. FUEL, rpm= 2100	RECTIFIER EFF, %= 99.5
	TRACK LENGTH, in.= 150	COOLING LOSSES, % Ghp= 4	ALTERNATOR P.F., %= 90
MAX. COURSE VELOCITY, mph= 45	TRACK PITCH, in.= 6.03	INLET/EXHAUST LOSSES, % Ghp= 1.5	MOTOR KM, V/krpm-A= .005
MAX. LAT. ACCEL., g's= .5	NUMBER OF SPROCKET TEETH= 11	AUXILIARY POWER, hp= 6	
	ROLLING RESISTANCE, lb. per ton= 100	FUEL CAPACITY, gal.= 175	
	MAXIMUM VELOCITY, mph= 45	SCHEDULING: VARIABLE	

**** ELECTRIC DRIVE PERFORMANCE ****

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
CHURCHVILLE	COMPACTED SOIL	45.00	0.50	19.5 TON	VTA-903	VARIABLE	HoPol P-A

**** MISSION COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. FORWARD VELOCITY (mph)	RANGE ESTIMATE (miles)
1	1	244	10.7	100	8.99	244	8.99	18.51	130.85

**** VEHICLE PERFORMANCE DATA ****

			INNER SPROCKET			OUTER SPROCKET			
FORWARD VELOCITY (mph)	TRACTIVE EFFORT (k-lbs)	LATERAL ACCELERATION (g's)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	NET DRIVE EFFICIENCY (%)
18.50	6.15	0.229	-103.91	275.84	-1978.51	440.67	313.21	7389.36	67.70

**** ENGINE / ENERGY DATA ****

HORSEPOWER GENERATED (hp)	SEGMENT ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	SEGMENT ENERGY LOSS (btu)	ENGINE SPEED (rpm)	FUEL CONSUMPTION (lb/hr)	FUEL CONSUMED (gal.)	FUEL REMAINING (gal.)	FUEL ECONOMY (mpg)
497.46	3161.99	3161.99	1021.48	2587.32	194.97	0.062	174.94	0.75

**** ELECTRIC DRIVE DATA ****

		INNER SPROCKET MOTOR			OUTER SPROCKET MOTOR		
ALTERNATOR SPEED (rpm)	ALTERNATOR POWER (kVA)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (hp)
11953.44	300.83	4597.35	-115.15	-100.79	5220.23	457.07	454.30
BUSS VOLTAGE (volts)	BUSS CURRENT (amps)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (kw)	VOLTAGE (volts)	CURRENT (amps)	FIELD POWER (kw)
7.33	45350.83	7.33	-9396.14	17.0	7.33	50211.88	13.2

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. FWD. ACCEL. (g's)	MAX. DECEL. (g's)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
MERADCOM TEST COURSE	CONCRETE/ASPHALT	45.00	0.50	0.20	0.50	19.5 TON	VTA-903	CONSTANT	HoFol P-G

**** COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. SEGMENT VELOCITY (mph)	AVG. MISSION VELOCITY (mph)
1	1	587.0	-0.10	0.0	16.93	587.00	16.93	23.64	23.64

**** VEHICLE PERFORMANCE DATA ****

*** CONSTANT VELOCITY ***				*** ACCELERATION ***			*** DECELERATION ***		
LATERAL ACCELERATION (g's)	FORWARD VELOCITY (mph)	DISTANCE (ft)	TIME (sec)	AVERAGE ACCELERATION (g's)	DISTANCE (ft)	TIME (sec)	AVERAGE DECELERATION (g's)	DISTANCE (ft)	TIME (sec)
0.00	33.08	6.28	0.13	0.09	580.72	16.80	0.00	0.00	0.00

**** ENERGY DATA ****

ENERGY GENERATED (btu)	ENERGY LOSSES (btu)	ENERGY REGENERATED (btu)	BRAKING ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	RANGE ESTIMATE (miles)	AVG. FUEL CONSUMPTION (lb/hr)	SEGMENT FUEL CONSUMED (gal)	FUEL REMAINING (gal)	FUEL ECONOMY (mpg)
5717.46	2152.69	0.00	0.00	5717.46	172.03	189.46	0.11	174.89	0.98

**** MISSION PARAMETERS ****

COURSE	SURFACE	MAX. VELOCITY (mph)	MAX. FWD. ACCEL. (g's)	MAX. DECEL. (g's)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ENGINE SCHEDULING	ELECTRIC DRIVE TYPE
MERADCOM TEST COURSE	CONCRETE/ASPHALT	45.00	0.50	0.20	0.50	19.5 TON	VTA-903	CONSTANT	HoFol P-G

**** COURSE DATA ****

LAP NO. (#)	SEGMENT NO. (#)	DISTANCE (ft)	GRADE (%)	RADIUS (ft)	TIME (sec)	CUMMULATIVE DISTANCE (ft)	CUMMULATIVE TIME (sec)	AVG. SEGMENT VELOCITY (mph)	AVG. MISSION VELOCITY (mph)
1	2	1173.0	-0.30	0.0	20.83	1760.00	37.76	38.39	31.78

**** VEHICLE PERFORMANCE DATA ****

*** CONSTANT VELOCITY ***				*** ACCELERATION ***			*** DECELERATION ***		
LATERAL ACCELERATION (g's)	FORWARD VELOCITY (mph)	DISTANCE (ft)	TIME (sec)	AVERAGE ACCELERATION (g's)	DISTANCE (ft)	TIME (sec)	AVERAGE DECELERATION (g's)	DISTANCE (ft)	TIME (sec)
0.00	42.03	1.68	0.03	0.02	1171.32	20.80	0.00	0.00	0.00

**** ENERGY DATA ****

ENERGY GENERATED (btu)	ENERGY LOSSES (btu)	ENERGY REGENERATED (btu)	BRAKING ENERGY (btu)	CUMMULATIVE ENERGY USED (btu)	RANGE ESTIMATE (miles)	AVG. FUEL CONSUMPTION (lb/hr)	SEGMENT FUEL CONSUMED (gal)	FUEL REMAINING (gal)	FUEL ECONOMY (mpg)
6855.26	2473.95	0.00	0.00	12572.72	235.20	186.30	0.13	174.75	1.34

VEHICLE ACCELERATION DYNAMICS

**** MISSION PARAMETERS ****

SURFACE	GRADE (%)	RADIUS (ft)	INITIAL VELOCITY (mph)	FINAL VELOCITY (mph)	MAX. FWD. ACCEL. (g's)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ELECTRIC DRIVE TYPE
COMPACTED SOIL	20.0	600	0.10	13.70	0.50	0.50	19.5 TON	VTA-903	HoPol 6-A

**** VEHICLE / SPROCKET DATA ****

					INNER SPROCKET			OUTER SPROCKET		
TIME (sec)	VELOCITY (mph)	DISTANCE (ft)	TRACTIVE EFFORT (K-lbs)	FORWARD ACCEL. (g's)	HORSEPOWER (Hp)	SPEED (rpm)	TORQUE (ft-lb)	HORSEPOWER (Hp)	SPEED (rpm)	TORQUE (ft-lbs)
0.1	1.00	0.08	27.99	0.410	3.64	1.58	12127	3.83	1.61	12500
0.2	1.83	0.29	26.64	0.380	34.60	15.75	11535	36.48	16.09	11908
0.3	2.60	0.61	25.30	0.350	60.21	28.90	10943	63.59	29.51	11316
0.4	3.33	1.05	24.40	0.330	82.35	41.00	10549	87.08	41.88	10921
0.5	3.99	1.59	23.06	0.300	99.36	52.41	9957	105.29	53.53	10330
0.6	4.60	2.22	22.16	0.280	114.32	62.79	9563	121.31	64.13	9935
0.7	5.17	2.93	21.26	0.260	126.51	72.47	9168	134.47	74.02	9541
0.8	5.70	3.73	20.37	0.240	136.09	81.46	8774	144.90	83.20	9147
0.9	6.18	4.60	19.47	0.220	143.22	89.76	8380	152.78	91.68	8753
1.0	6.62	5.54	18.57	0.200	148.05	97.37	7986	158.27	99.45	8358
1.5	8.65	11.14	17.90	0.185	152.69	104.29	7690	163.52	106.52	8063
2.0	9.91	17.95	14.77	0.115	163.74	136.28	6311	177.12	139.19	6683
2.5	10.76	25.53	13.07	0.077	165.39	156.16	5562	180.24	159.50	5935
3.0	11.36	33.64	12.08	0.055	165.51	169.48	5129	181.34	173.10	5502
3.5	11.81	42.14	11.46	0.041	165.42	178.99	4854	181.93	182.81	5227
4.0	12.16	50.94	11.05	0.032	165.70	186.08	4677	182.73	190.05	5050
4.5	12.44	59.96	10.74	0.025	165.61	191.61	4539	183.04	195.70	4912
5.0	12.66	69.16	10.52	0.020	165.68	195.93	4441	183.42	200.12	4814
5.5	12.83	78.51	10.34	0.016	165.62	199.39	4363	183.61	203.65	4735
6.0	12.98	87.98	10.21	0.013	165.65	202.16	4304	183.85	206.48	4676
6.5	13.10	97.54	10.12	0.011	165.97	204.40	4265	184.33	208.77	4637
7.0	13.20	107.18	10.03	0.009	165.97	206.31	4225	184.47	210.72	4598
7.5	13.28	116.90	9.98	0.008	166.45	207.86	4206	185.07	212.31	4578
8.0	13.35	126.66	9.89	0.006	165.99	209.25	4166	184.70	213.72	4539
8.5	13.40	136.48	9.85	0.005	166.03	210.28	4147	184.82	214.78	4519
9.0	13.45	146.32	9.80	0.004	165.92	211.15	4127	184.77	215.66	4500
9.5	13.49	156.20	9.80	0.004	166.47	211.84	4127	185.38	216.37	4500
10.0	13.53	166.11	9.76	0.003	166.22	212.53	4108	185.17	217.07	4480
11.0	13.57	185.99	9.71	0.002	165.82	213.05	4088	184.81	217.60	4461
12.0	13.61	205.92	9.72	0.002	166.36	213.74	4088	185.41	218.31	4461
13.0	13.64	225.91	9.67	0.001	166.10	214.43	4068	185.19	219.02	4441
14.0	13.66	245.93	9.67	0.001	166.37	214.78	4068	185.49	219.37	4441
15.0	13.68	265.98	9.67	0.001	166.64	215.13	4068	185.79	219.72	4441
16.0	13.68	265.98	9.67	0.000	166.91	215.47	4068	186.09	220.08	4441

GEAR REDUCTION DYNAMICS

**** MISSION PARAMETERS ****

SEG. NO. (#)	COURSE	SURFACE	GRADE (%)	RADIUS (ft)	FORWARD VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ELECTRIC DRIVE TYPE
1	CHURCHVILLE COURSE	COMPACTED SOIL	10.7	100	15.80	0.50	19.5 TON	VTA-903	HoPol S-G

**** GEARBOX DATA ****

OUTER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	INNER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	DIESEL INTERFACE GEAR	SPEED (rpm)	TORQUE (ft-lb)
GB2-A	4458.4	443.0	GB2-A	3926.4	-119.1	GB1-A	2592.0	1009.9
GB2-B	1486.1	1329.0	GB2-B	1308.8	-357.2	GB1-B	5184.0	504.9
GB2-C	743.1	2658.0	GB2-C	654.4	-714.4	GB1-C	11975.0	218.6
GB2-D	267.5	7383.4	GB2-D	235.6	-1984.4			

**** MISSION PARAMETERS ****

SEG. NO. (#)	COURSE	SURFACE	GRADE (%)	RADIUS (ft)	FORWARD VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ELECTRIC DRIVE TYPE
2	CHURCHVILLE COURSE	COMPACTED SOIL	11.1	0	19.20	0.50	19.5 TON	VTA-903	HoPol S-G

**** GEARBOX DATA ****

OUTER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	INNER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	DIESEL INTERFACE GEAR	SPEED (rpm)	TORQUE (ft-lb)
GB2-A	5094.5	166.5	GB2-A	5094.5	166.5	GB1-A	2596.7	1010.0
GB2-B	1698.2	499.4	GB2-B	1698.2	499.4	GB1-B	5193.4	505.0
GB2-C	849.1	998.8	GB2-C	849.1	998.8	GB1-C	11996.8	218.6
GB2-D	305.7	2774.5	GB2-D	305.7	2774.5			

**** MISSION PARAMETERS ****

SEG. NO. (#)	COURSE	SURFACE	GRADE (%)	RADIUS (ft)	FORWARD VELOCITY (mph)	MAX. LAT. ACCEL. (g's)	VEHICLE	ENGINE	ELECTRIC DRIVE TYPE
3	CHURCHVILLE COURSE	COMPACTED SOIL	-7.7	0	45.00	0.50	19.5 TON	VTA-903	HoPol S-G

**** GEARBOX DATA ****

OUTER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	INNER SPROCKET GEAR	SPEED (rpm)	TORQUE (ft-lb)	DIESEL INTERFACE GEAR	SPEED (rpm)	TORQUE (ft-lb)
GB2-A	11940.3	-19.8	GB2-A	11940.3	-19.8	GB1-A	2596.7	-11.2
GB2-B	3980.1	-59.3	GB2-B	3980.1	-59.3	GB1-B	5193.4	-5.6
GB2-C	1990.0	-118.6	GB2-C	1990.0	-118.6	GB1-C	11996.8	-2.4
GB2-D	716.4	-329.5	GB2-D	716.4	-329.5			

APENDIX F

CONTRACT VEHICLE AND PROPULSION

SYSTEM SPECIFICATIONS

ATTACHMENT 1

SPECIFICATIONS

1. General Vehicle Specifications (Fig. 2):

Frontal Area	6.34 sq m (68.25 ft^2)
Gross Vehicle Weight	36.3 ton (40 ton)
Vehicle Top Speed (Governed)	73 Km/hr (45 mph)
Track Length (forward to aft roadwheel centerline)	4650 mm (183.07 in.)
Distance between track longitudinal centerline)	2790 mm (109.84 in)
Track Width	580 mm (22.83 in.)

2. Propulsion System Specifications:

a. Transmission: (Electric Drive System)

The drive system shall provide automatic speed ration control and inhibitors to prevent engine overspeed. Maximum output torque required shall be sufficient to generate a tractive effort of 427,000 Newtons, Reverse - 427,000 Newtons. There shall be tactile feedback to the driver when the transmission is in forward or reverse operational mode. The power train shall provide for safe, predictable performance for extended periods at speeds below 5 Km/hr.

b. Steer System:

A regenerative speed control system is required. Differential torque between sides shall be equal to maximum steer torque. Pivot steer capability on hard surface shall be 7 revolutions/min. The steering controls shall remain operative in the event of engine failure or vehicle towing. The steer system shall be capable of accepting full engine power.

c. Cooling Capability:

Capable of continuous tractive effort operation of at least 250,000 N.

d. Braking:

The vehicle shall be capable of a deceleration rate from maximum speed on level hard surface road at least 7 m/sec^2 (peak) and 5 m/sec^2 (avg.). The vehicle shall be capable of an included hold with engine off on at least a 60% slope. The vehicle shall be capable of at least 25 stops from 60 Km/hr @ 5 m/sec^2 @ 3 minute intervals. The braking functions shall be accomplished by two separate mechanisms to allow redundance for emergency purposes.

ATTACHMENT 1 (Cont'd)

e. Electric/Hydraulic Power Capability:

Continuous operation of all vehicle electrical and hydraulic systems shall be at least 7 Kw, to include silent watch - the silent watch is non-mobile, with noise, light, and smoke discipline. The above power requirement covers turret hydraulic, radio and other electrical needs, compartment ventilation and NBC countermeasure equipment. Electrical and hydraulic power sources must be capable of operating independently or in parallel in a stable self regulating manner. Average auxiliary power usage is 3.5 Kw.

f. Speed on Grade:

The propulsion system shall be capable of sustaining forward vehicles speeds on hard surface roads and grades as defined in Figure 1.

g. Acceleration:

The vehicle shall be capable of acceleration on dry level surface from idle, from application of the throttle, in the forward direction from zero to 32.2 Km/jr (20 mph) in seven seconds; and in reverse direction from zero to 16 Km/hr (10 mph), in five seconds. Assume no "throttle" linkage delay.

h. Engine: See figures 4 and 5.

i. Shock:

The electric drive system must be able to withstand a 15 g shock load in any direction.

ATTACHMENT 2

SPECIFICATIONS

1. General Vehicle Specifications (Fig. 3):

Frontal Area	5.3 sq m (57 ft^2)
Gross Vehicle Weight	17.6 ton (19.5 ton)
Vehicle Top Speed (Governed)	73 Km/hr (45 mph)
Track Length (forward to aft roadwheel centerline)	3810 mm (150.0 in)
Distance between track longitudinal centerline)	2350 mm (92.52 in)
Track Width	445 mm (17.52 in)

2. Propulsion System Specifications:

a. Transmission: (Electric Drive System)

The drive system shall provide automatic speed ration control and inhibitors to prevent engine overspeed. Maximum output torque required shall be sufficient to generate a tractive effort of 208,000 Newtons, Reverse - 208,000 Newtons. There shall be tactile feedback to the driver when the transmission is in forward or reverse operational mode. The power train shall provide for safe, predictable performance for extended periods at speeds below 5 Km/hr.

b. Steer System:

A regenerative speed control system is required. Differential torque between sides shall be equal to maximum steer torque. Pivot steer capability on hard surface shall be 7 revolutions/min. The steering controls shall remain operative in the event of engine failure or vehicle towing. The steer system shall be capable of accepting full engine power.

c. Cooling Capability:

Capable of continuous tractive effort operation of at least 121,500 N.

d. Braking:

The vehicle shall be capable of a deceleration rate from maximum speed on level hard surface road at least 7 m/sec^2 (peak) and 5 m/sec^2 (avg.). The vehicle shall be capable of an included hold with engine off on at least a 60% slope. The vehicle shall be capable of at least 25 stops from 60 Km/hr @ 5 m/sec^2 @ 3 minute intervals. The braking functions shall be accomplished by two separate mechanisms to allow redundance for emergency purposes.

ATTACHMENT 2 (Cont'd)

e. Electric/Hydraulic Power Capability:

Continuous operation of all vehicle electrical and hydraulic systems shall be at least 7 Kw, to include silent watch - the silent watch is non-mobile, with noise, light, and smoke discipline. The above power requirement covers turret hydraulic, radio and other electrical needs, compartment ventilation and NBC countermeasure equipment. Electrical and hydraulic power sources must be capable of operating independently or in parallel in a stable self regulating manner. Average auxiliary power usage is 2.5 Kw.

f. Speed on Grade:

The propulsion system shall be capable of sustaining forward vehicles speeds on hard surface roads and grades as defined in Figure 1.

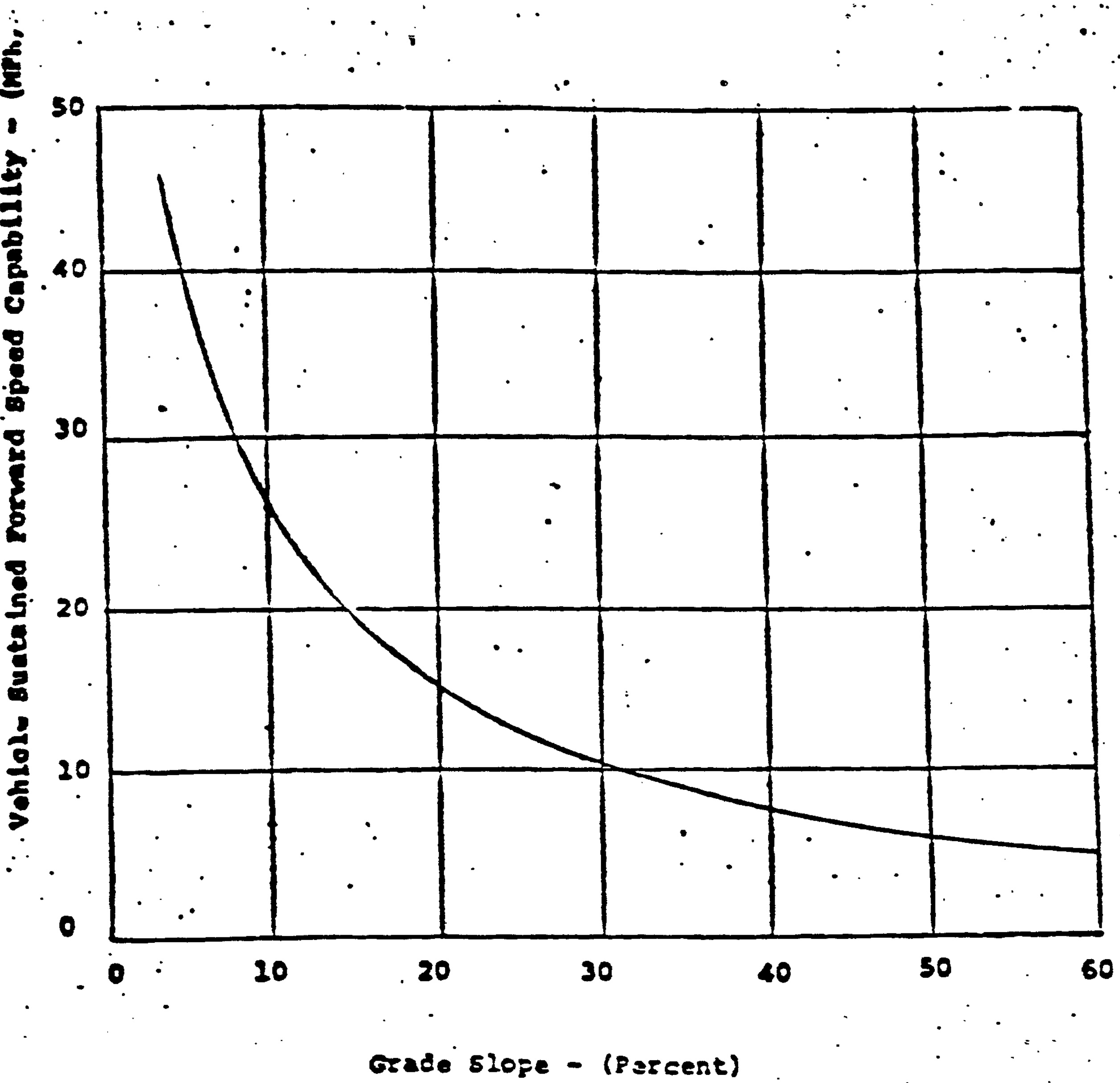
g. Acceleration:

The vehicle shall be capable of acceleration on dry level surface from idle, from application of the throttle, in the forward direction from zero to 32.2 Km/jr (20 mph) in seven seconds; and in reverse direction from zero to 16 Km/hr (10 mph), in five seconds. Assume no "throttle" linkage delay.

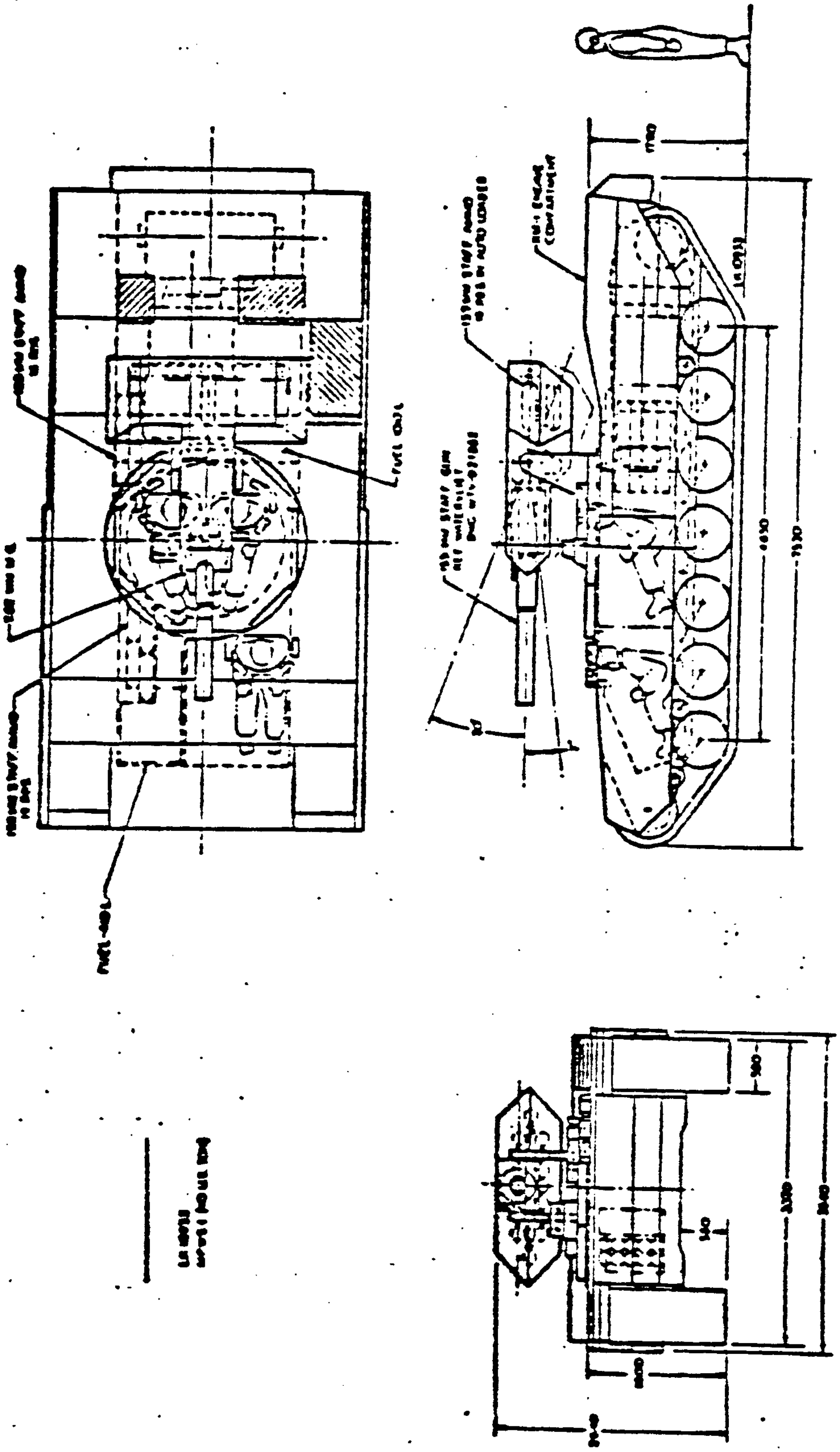
h. Engine: See figures 4 and 5.

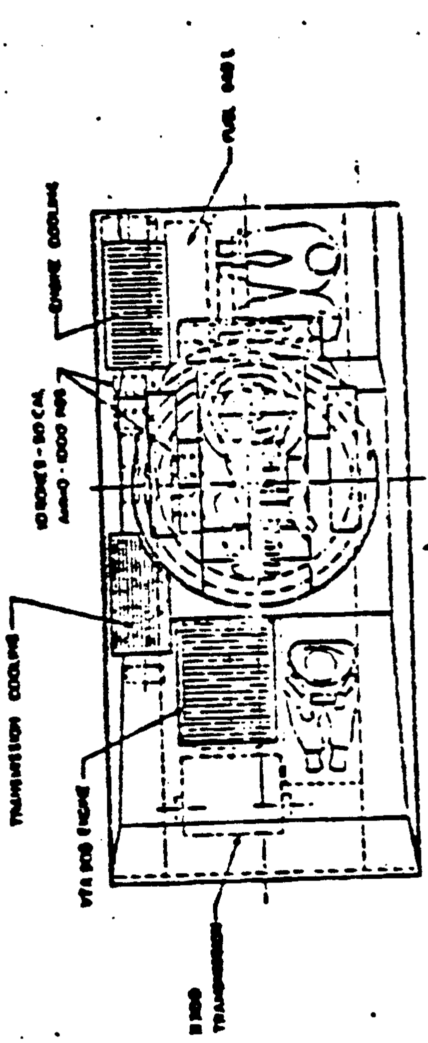
i. Shock:

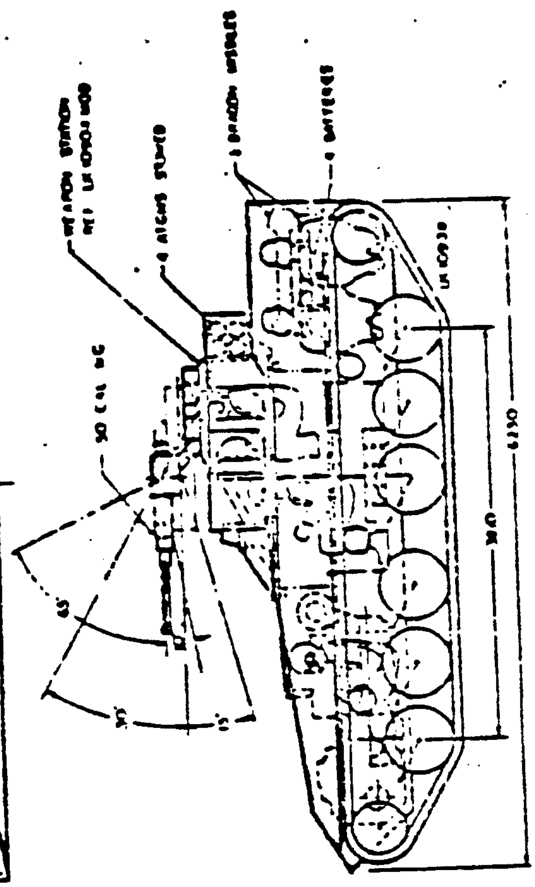
The electric drive system must be able to withstand a 15 g shock load in any direction.

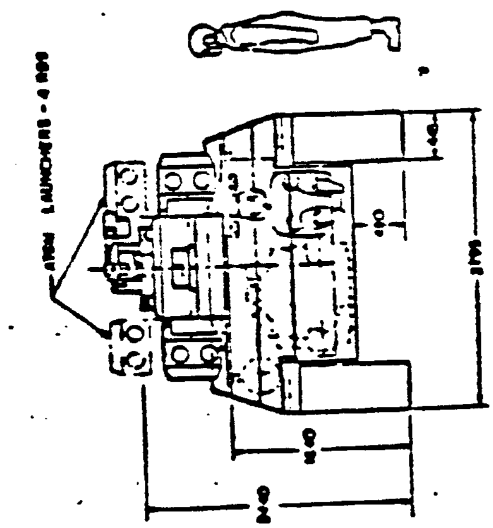


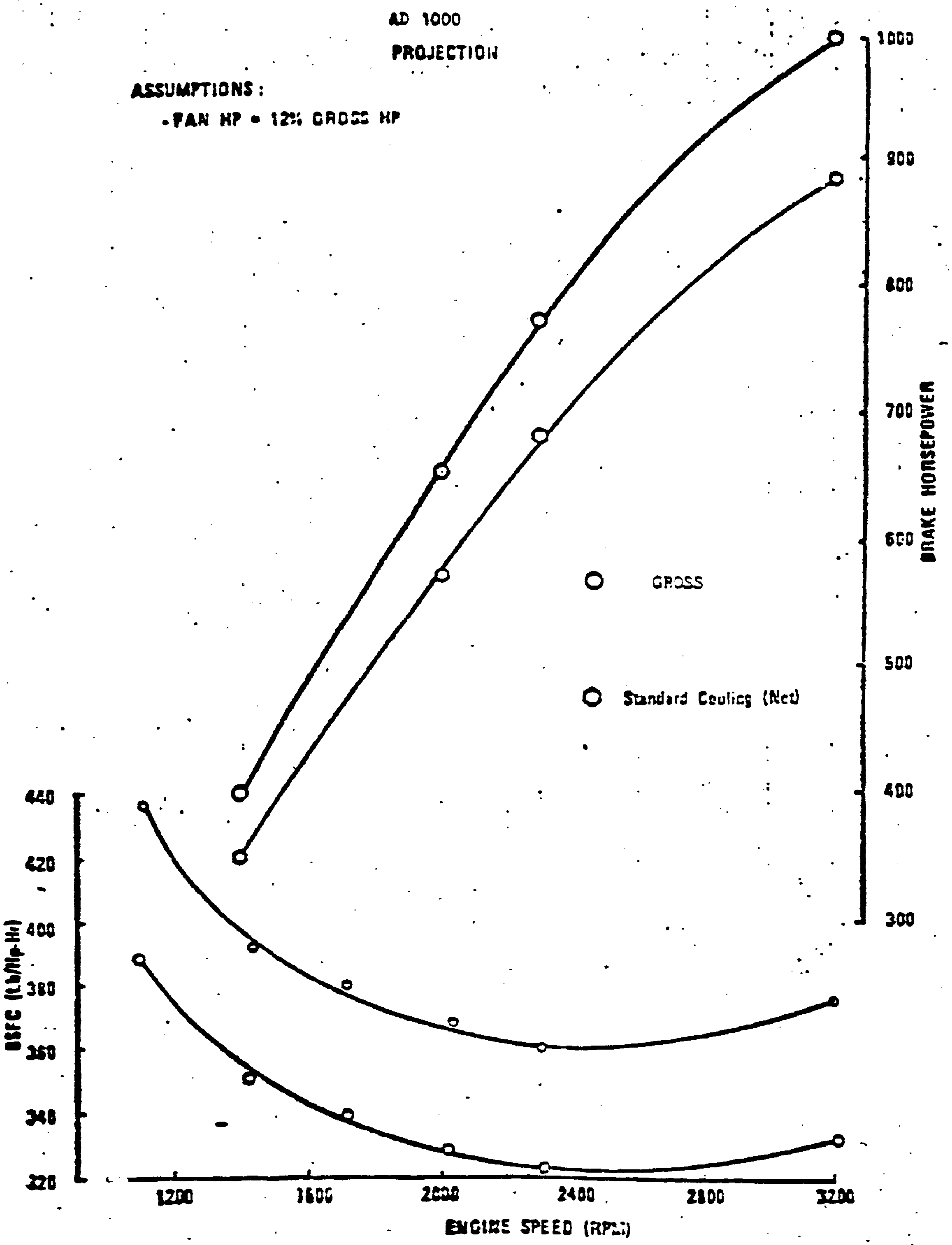
NOTE: Performance shall be measured over hard-surface roads.

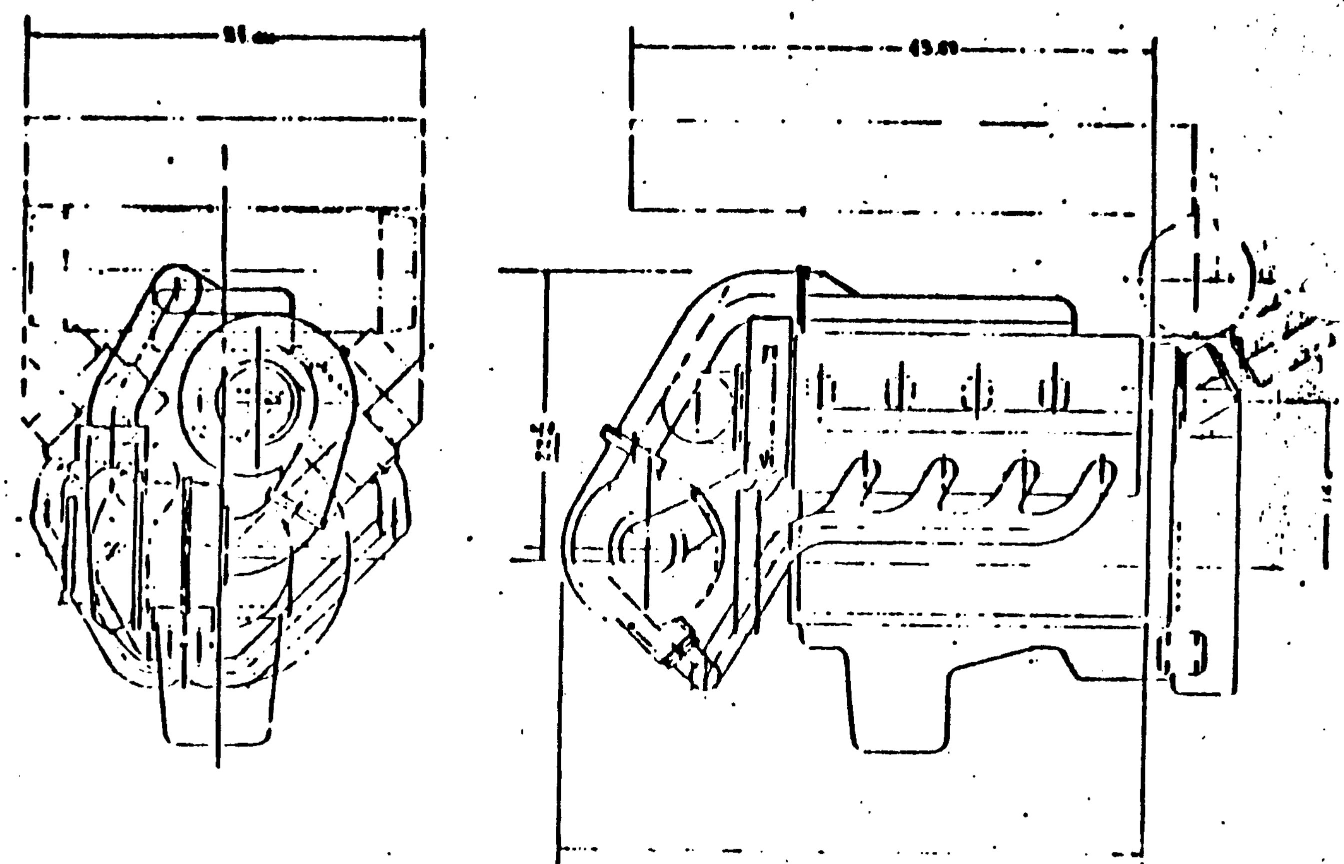









AD 1000
PROJECTION
ASSUMPTIONS :
• FAN HP = 12% GROSS HP
GROSS
Standard Cooling (Net)
BRAKE HORSEPOWER
1000
900
800
700
600
500
400
300
BSFC (Lb/Hp-Hr)
440
420
400
380
360
340
320
1200
1600
2000
2400
2800
3200
ENGINE SPEED (RPM)

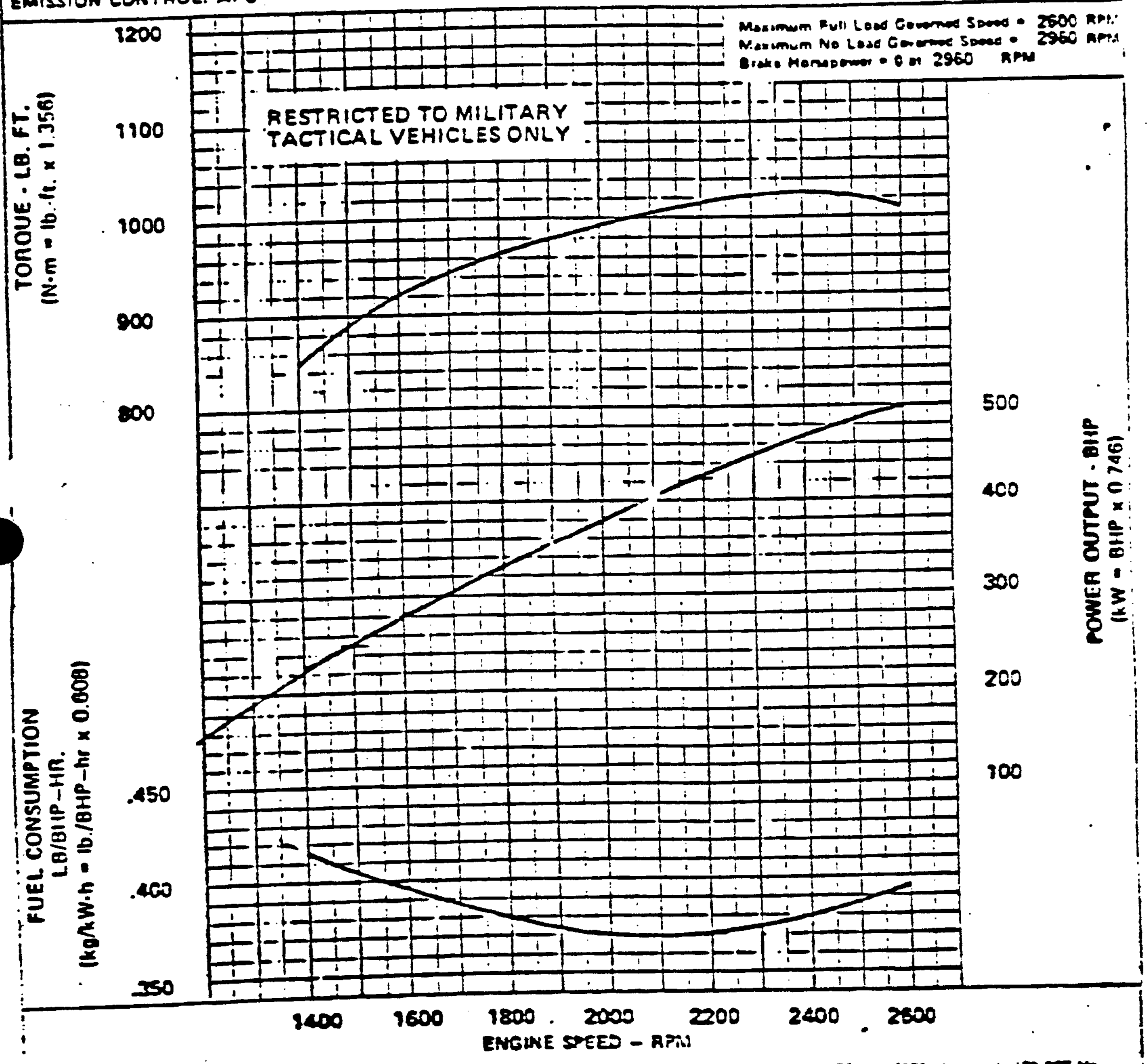


RADIAL TURBOCOMPOUND SYSTEM LAYOUT

AD 1000

CUMMINS ENGINE COMPANY, INC. Columbus, Indiana 47201 AUTOMOTIVE PERFORMANCE CURVE	BASIC ENGINE MODEL: VTA-903-T		CURVE NUMBER: RC-3914-A	
	ENGINE FAMILY:	CPL CODE: 0383	DATE: 4/12/79	BY: M.L.S.

DISPLACEMENT: 903 in^3 (14.8 litre) ASPIRATION: TURBOCHARGED & AFTERCOOLED RATING: HP (kW) @ RPM
BORE: 5.5 in (140 mm) STROKE: 4.75 in (121 mm) NO. OF CYLINDERS: 8 500 (373) @ 2600
EMISSION CONTROL: AFC FUEL SYSTEM: PT



Curves shown above represent engine performance capabilities at SAE standard J816b conditions of 500 ft. (150m) altitude (29.00" Hg (736mm Hg) dry barometer), 85°F (29°C) air intake temperature, and 0.38" Hg (10mm Hg) water vapor pressure with No. 2 diesel fuel.

STANDARDS DEPT. CERTIFIED WITHIN 5%. S. L. Goel CHIEF ENGINEER

propulsion and steer element torques (lb-ft).

1010 LB-FT. MAX. INPUT TORQUE
2400 RPM TRANSMISSION INPUT SPEED

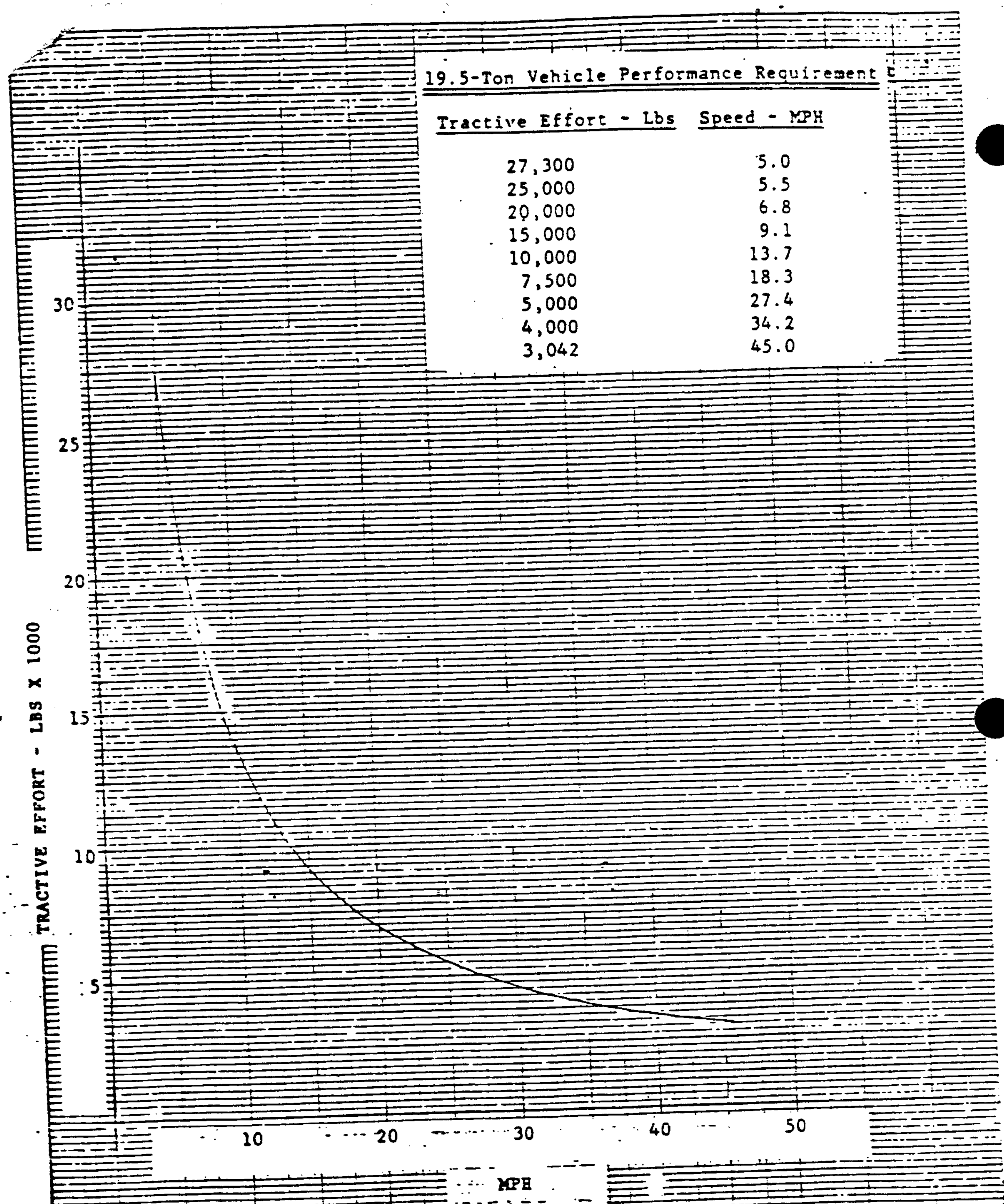
OUTPUT SPEED (RPM)	377 SPUR GEAR INPUT	371 SPUR GEAR, 107 BEVEL GEAR	107 BEVEL GEAR	307 SPUR GEAR	777 SPUR GEAR, P1 RING GEAR	P1 CARRIER	P1 SUN GEAR	571 SPUR GEAR, C2 HOUSING	PROPULSION HYDROSTATIC PUMP	PROPULSION HYDROSTATIC MOTOR	P2 SUN GEAR	P2 CARRIER, C1 HUB	P2 RING GEAR
-600	1510	-1306	1306	1306	-1299	-2026	737	0	-2026	-2189	-1452	-5688	4236
-500	1484	-1283	1283	1283	-1267	-1991	724	0	-1991	-2437	-1713	-6709	4996
-400	1263	-1097	1097	1092	-1078	-1694	616	0	-1694	-2437	-1821	-7132	5311
-300	1010	-874	874	874	-863	-1356	491	0	-1356	-2437	-1944	-7614	5670
-200	771	-624	624	624	-616	-968	352	0	-968	-2437	-2085	-8166	6081
-100	389	-337	337	337	-332	-523	190	0	-523	-2437	-2247	-8800	6554
0	0	0	0	0	0	0	0	0	0	2437	2417	9545	-7107
100	401	-399	399	399	-394	-619	225	0	-619	2437	2662	10476	-7764
200	1017	-879	879	879	-868	-1364	496	0	-1364	2437	2933	11484	-8555
300	1510	-1306	1306	1306	-1289	-2026	737	0	-2026	2160	2905	11318	-8473
400	1510	-1306	1306	1306	-1289	-2026	737	0	-2026	1006	2179	8534	-6355
500	1510	-1306	1306	1306	-1289	-2026	737	0	-2026	715	1743	6827	-5084
600	1510	-1306	1306	1306	-1289	-2026	737	0	-2026	737	1452	5639	-4236
700	1510	-1306	1306	1306	-1289	-2026	737	-3872	-1796	737	0	0	0
800	1510	-1306	1306	1306	-1289	-2026	737	-3344	-1319	737	0	0	0
900	1510	-1306	1306	1306	-1289	-2026	737	-2973	-947	737	0	0	0
1000	1510	-1306	1306	1306	-1289	-2026	737	-2675	-650	737	0	0	0
1100	1510	-1306	1306	1306	-1289	-2026	737	-2437	-406	737	0	0	0
1200	1510	-1306	1306	1306	-1289	-2026	737	-2230	-204	737	0	0	0
1300	1510	-1306	1306	1306	-1289	-2026	737	-2050	-32	737	0	0	0
1400	1510	-1306	1306	1306	-1289	-2026	737	-1911	115	737	0	0	0
1500	1510	-1306	1306	1306	-1289	-2026	737	-1784	242	737	0	0	0
1600	1510	-1306	1306	1306	-1289	-2026	737	-1672	354	737	0	0	0
1700	1510	-1306	1306	-436	430	675	-246	0	675	1100	854	0	0
1800	1510	-1306	1306	-339	334	525	-193	0	525	997	806	0	0
1900	1510	-1306	1306	-252	249	391	-147	0	391	906	764	0	0
2000	1510	-1306	1306	-174	172	270	-98	0	270	824	776	0	0
2100	1510	-1306	1306	-104	102	161	-59	0	169	750	693	0	0
2200	1510	-1306	1306	-40	39	67	-27	0	67	682	660	0	0
2300	1510	-1306	1306	19	-18	-29	11	0	-29	620	631	0	0
2400	1510	-1306	1306	77	-72	-112	41	0	-112	564	605	0	0
2500	1510	-1306	1306	122	-120	-189	69	0	-189	517	581	0	0
2600	1510	-1306	1306	167	-165	-260	94	0	-260	465	559	0	0
2700	1510	-1306	1306	209	-207	-325	118	0	-325	420	538	0	0
2800	1510	-1306	1306	249	-246	-386	140	0	-386	393	518	0	0
2900	1510	-1306	1306	285	-281	-442	161	0	-442	343	501	0	0
3000	1510	-1306	1306	319	-315	-495	180	0	-495	304	484	0	0
3100	1510	-1306	1306	351	-346	-544	198	0	-544	273	460	0	0
3200	1510	-1306	1306	380	-376	-591	215	0	-591	239	454	0	0

Figure 8

propulsion and steer system element speeds--3000 rpm transmission input speed.

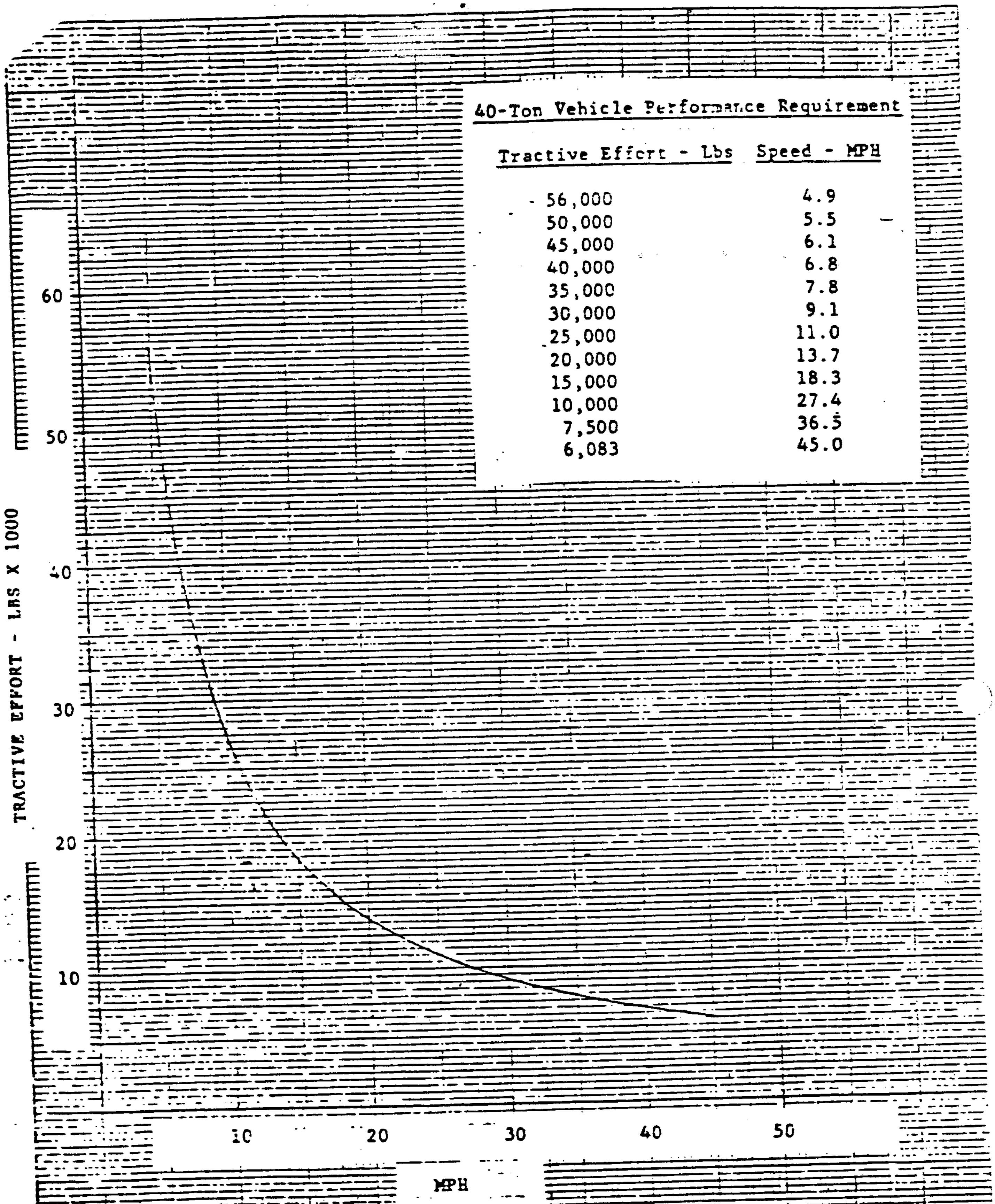
OUTPUT SPEED (RPM)	P1,P2,P3 SUN GEARS	80T SPUR GEAR, C2 HUB, OUTPUT PLANETARY RING GEARS	C1 HUB, P2 CARRIER	56T SPUR GEAR, P2 RING GEAR, P3 RING GEAR	80T SPUR GEAR, P3 CARRIER	57T SPUR GEAR, C2 HOUSING	C3 HOUSING, 60T SPUR GEAR	F1 CARRIER, 57T SPUR GEAR	??T SPUR GEAR, F1 RING GEAR, STEER HYDROSTATIC PUMP	OUTPUT PLANETARY CARRIERS	19T BEVEL DRIVEN GEAR, C3 HUB, 70T SPUR GEAR	32T SPUR GEAR, 19T BEVEL DRIVE GEAR	37T SPUR GEAR
-600	-2704	-880	0	927	-393	2921	530	-2921	-3045	-600	3006	-3006	2600
-500	-2253	-733	0	773	-327	2757	442	-2757	-3045	-500	3006	-3006	2600
-400	-1803	-587	0	618	-262	2593	354	-2593	-3045	-400	3006	-3006	2600
-300	-1352	-440	0	464	-197	2430	265	-2430	-3045	-300	3006	-3006	2600
-200	-901	-293	0	309	-131	2266	177	-2266	-3045	-200	3006	-3006	2600
-100	-451	-147	0	155	-66	2102	88	-2102	-3045	-100	3006	-3006	2600
0	0	0	0	0	0	1938	0	-1938	-3045	0	3006	-3006	2600
100	451	147	0	-155	66	1774	-88	-1774	-3045	100	3006	-3006	2600
200	901	293	0	-309	131	1610	-177	-1610	-3045	200	3006	-3006	2600
300	1352	440	0	-464	197	1446	-265	-1446	-3045	300	3006	-3006	2600
400	1803	587	0	-618	262	1282	-354	-1282	-3045	400	3006	-3006	2600
500	2253	733	0	-773	327	1119	-442	-1119	-3045	500	3006	-3006	2600
600	2704	880	0	-927	393	955	-530	-955	-3045	600	3006	-3006	2600
700	2506	1027	-184	-1032	223	1027	-300	-1027	-3045	700	3006	-3006	2600
800	2102	1173	-384	-1236	-72	1173	30	-1173	-3045	800	3006	-3006	2600
900	1693	1320	-602	-1391	-267	1320	360	-1320	-3045	900	3006	-3006	2600
1000	1290	1467	-820	-1545	-512	1467	691	-1467	-3045	1000	3006	-3006	2600
1100	852	1613	-1038	-1700	-757	1613	1021	-1613	-3045	1100	3006	-3006	2600
1200	496	1760	-1256	-1854	-1002	1760	1351	-1760	-3045	1200	3006	-3006	2600
1300	-86	1902	-1474	-2009	-1247	1907	1682	-1907	-3045	1300	3006	-3006	2600
1400	-317	2053	-1692	-2163	-1492	2053	2012	-2053	-3045	1400	3006	-3006	2600
1500	-703	2200	-1910	-2318	-1737	2200	2342	-2200	-3045	1500	3006	-3006	2600
1600	-1124	2347	-2128	-2472	-1982	2347	2673	-2347	-3045	1600	3006	-3006	2600
1700	-1547	2453	-2223	-2627	-2051	2319	3006	-2319	-3045	1700	3006	-3006	2600
1800	-807	2640	-2277	-2782	-2062	2231	3006	-2231	-3045	1800	3006	-3006	2600
1900	-540	2787	-2331	-2936	-2074	2145	3006	-2145	-3045	1900	3006	-3006	2600
2000	-327	2933	-2385	-3091	-2085	2057	3006	-2057	-3045	2000	3006	-3006	2600
2100	-88	3080	-2439	-3245	-2096	1970	3006	-1970	-3045	2100	3006	-3006	2600
2200	151	3227	-2762	-3400	-2108	1883	3006	-1883	-3045	2200	3006	-3006	2600
2300	391	3373	-2547	-3554	-2119	1796	3006	-1796	-3045	2300	3006	-3006	2600
2400	631	3520	-2601	-3709	-2130	1709	3006	-1709	-3045	2400	3006	-3006	2600
2500	870	3667	-2655	-3863	-2141	1621	3006	-1621	-3045	2500	3006	-3006	2600
2600	1110	3813	-2709	-4018	-2152	1534	3006	-1534	-3045	2600	3006	-3006	2600
2700	1350	3960	-2762	-4172	-2164	1447	3006	-1447	-3045	2700	3006	-3006	2600
2800	1589	4107	-2816	-4327	-2175	1360	3006	-1360	-3045	2800	3006	-3006	2600
2900	1829	4253	-2870	-4481	-2186	1273	3006	-1273	-3045	2900	3006	-3006	2600
3000	2069	4400	-2924	-4636	-2198	1186	3006	-1186	-3045	3000	3006	-3006	2600
3100	2302	4547	-2978	-4790	-2209	1099	3006	-1099	-3045	3100	3006	-3006	2600
3200	2549	4963	-3032	-4945	-2220	1011	3006	-1011	-3045	3200	3006	-3006	2600

Figure 7



19.5-Ton Vehicle Performance Requirement

Tractive Effort - Lbs	Speed - MPH
27,300	5.0
25,000	5.5
20,000	6.8
15,000	9.1
10,000	13.7
7,500	18.3
5,000	27.4
4,000	34.2
3,042	45.0



40-Ton Vehicle Performance Requirement

Tractive Effort - Lbs	Speed - MPH
56,000	4.9
50,000	5.5
45,000	6.1
40,000	6.8
35,000	7.8
30,000	9.1
25,000	11.0
20,000	13.7
15,000	18.3
10,000	27.4
7,500	36.5
6,083	45.0

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APENDIX G

HOMOPOLAR MACHINE DESCRIPTION

APPENDIX G Homopolar Machine Description

One of the vehicle drive system concepts selected utilizes homopolar (single pole) machines as the propulsive component. These direct current (DC) machines are characterized by the low voltage ($\angle$ 50V) and high current nature of their output and the simplicity which is inherent in their design.

G.1 Homopolar Machine Operation

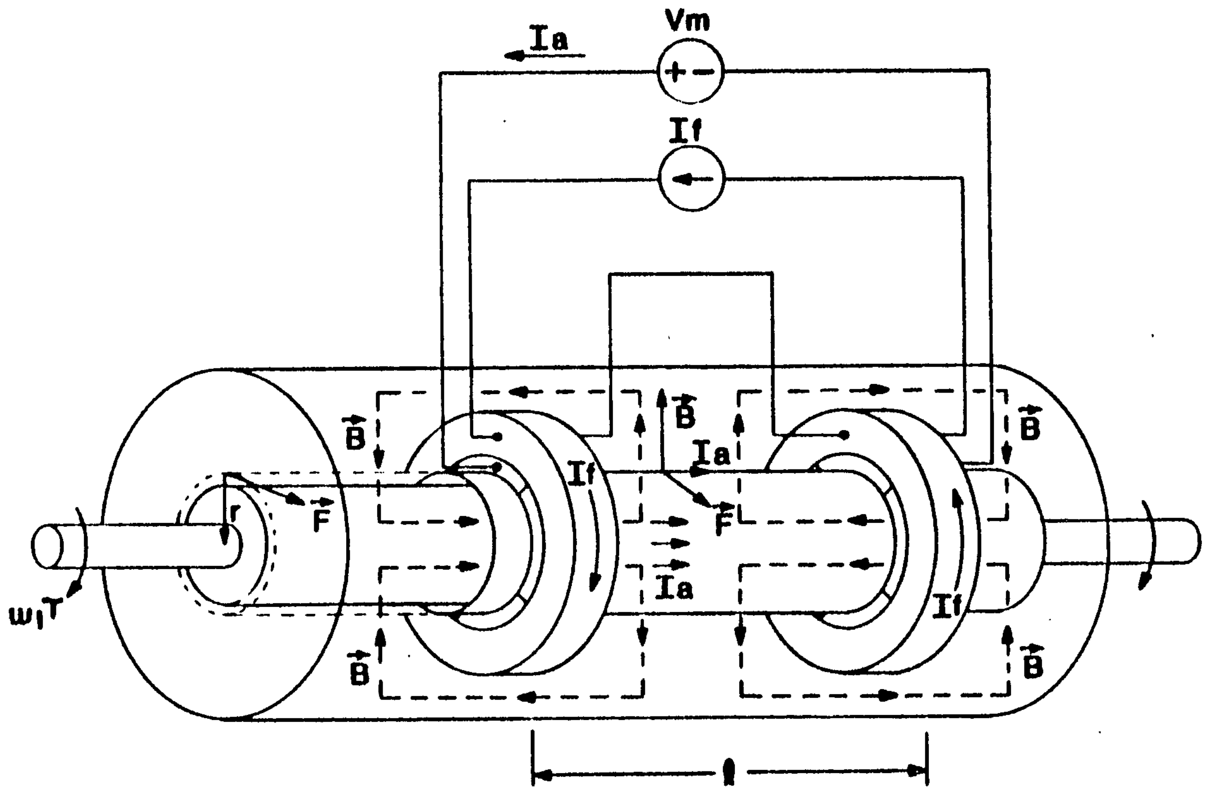
G.1.1 Voltage Generation

Operation of the homopolar machine is governed by Faraday's Law, which relates the mechanical machine parameters, rotational velocity, and magnetic flux to the voltage produced across the rotor (armature). Specifically, $V \propto Bwr\ell$ where;

- V = the voltage generated across the armature
- B = the density of the magnetic flux passing through the rotor
- w = the rotational velocity of the rotor
- r = the radius of the rotor drum
- ℓ = the active machine length (defined as the length of the rotor across which the magnetic flux passes)

The manner in which this relation is satisfied by the machine is shown in Figure G.1.1-1. A solid rotor drum, made of iron or other low magnetic reluctance material, is captured within a thin conducting sleeve which is electrically insulated from the rotor. Electrical connections are made around the periphery at each end of the sleeve by a series of sliding brush contacts. Field coils, which are wound in opposite directions from one another in a circumferential manner, are placed around the rotor near each end. The entire structure is encased within a housing of magnetic material to provide a low reluctance return path for the magnetic flux. During operation as a generator (the homopolar machine acts equally well in a motoring mode) the field coils are excited with a DC current If, giving rise to a toroidally oriented magnetic flux about each of the coils. The net flux density which passes across the active length of the rotor (ℓ) is the combined field from each of the field coils. As the rotor is turned at a rotational speed w, the lines of magnetic flux B are constantly cut by the active length ℓ, generating a differential voltage across the rotor drum which satisfies Faraday's Law. This voltage is available at the two brush rings, and if connected to a load, will result in the flow of armature current I_a.

BASIC HOMOPOLAR MACHINE OPERATION



Defining Equations: $d\vec{T} = (I_a d\vec{\ell} \times \vec{B}) \times \vec{r}$, $[|\vec{T}| = I_a \ell |\vec{B}| |\vec{r}|]$

$$V_m = V_a + I_a R_a \quad \text{where} \quad V_a = N\frac{d\Phi}{dt} = (1)|\vec{B}|\frac{dA}{dt} = |\vec{B}|\ell\frac{d\theta}{dt} = |\vec{B}|\ell\omega$$

$$[V_m = |\vec{B}|\ell\omega + I_a R_a]$$

G.1.2 Torque Generation

The generation of torque by the homopolar machine is governed by the vector relation $\vec{\tau} = Ia\ (\vec{l} \times \vec{B}) \times \vec{r}$ and is best understood through consideration of the machine in a motoring mode. With the field coils excited and a potential Vm applied across the armature, an armature current Ia flows proportional to whatever resistance is encountered in the armature circuit. The interaction of the two orthogonal vectors in the directions of the magnetic flux and the armature current give rise to a generated force tangential to the rotor drum. The vector cross product of this force with the radius vector of the machine results in a generated torque about the axis of the rotor. This torque is then transmitted along the shaft.

G.2 Homopolar Machine Characteristics

G.2.1 Machine Losses

Homopolar electrical losses are a function of three components; field coil resistance, armature sleeve resistance, and brush contact potential drop and resistance. Of these, the brush losses are the most significant contributor, due to the resistance vs wear tradeoff which must be analyszed when the brush materai is selected. For example, a greater brush force will accelerate brush wear, but will result in a lower resistance and less heating. Lower heat dissipation then helps to lengthen brush life. Active brush cooling helps to reduce some of these factors significantly. Mechanical losses are those normally associated with rotary machinery; i.e., friction and windage. These losses are most prevalent in the machine, and account for the majority of the total losses, particularly if there is little electrical load.

G.2.2 Speed/Torque Characteristics

Electrical machines are characterized by the speed vs torque profile which defines the operatng limits at any particular load. A representative curve for a homopolar machne is given in Figure G.2.2-1. The primary machine limitation is thermal rather than magnetic saturation or reaction torque demagnetization (as with permanent magnet DC motors). As long as adequate heat removal is provided, the homopolar machine can deliver rated torque over the full speed range of the machine. Higher, noncontinuous torques at stall or very low speeds are also attainable and can be maintained with sufficient cooling. Stall torque levels are ultimately limited by brush current density, which coupled with the rotor tip speed, for an envelope whic defines the maximum transient load.

G.2.3 Homopolar Gain/Control

A primary advantage of homopolar machines is the ability to control their operation through excitation of the field windings

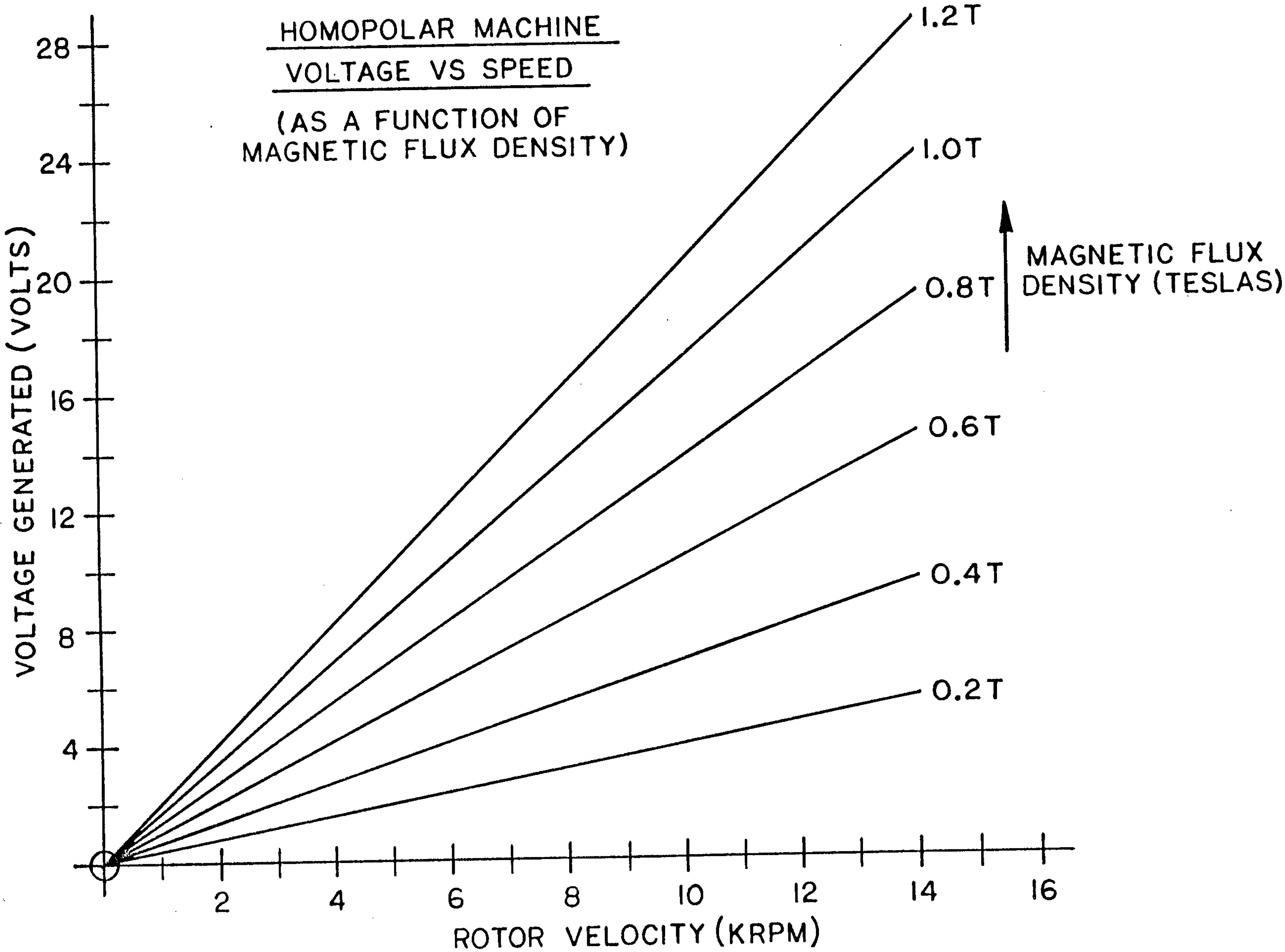
at a much reduced power level. This is in contrast to all AC drive systems which require that a series controller capable of handling the entire motor power be used to generate the necessary AC waveforms. Homopolar machine gain is defined as the ratio of the output power (mechanical for the motoring mode, electrical for the generating mode) to the full excitation power of the field coils. Present homopolar designs yield gains on the order of 25. The method of control is best demonstrated by Figure G.2.3-1, which presents a family of linear speed vs voltage curves. Due to the simplicity of construction and single pole nature of the machine, generated armature voltage is a linear function of rotational velocity. The magnitude of the voltage is controlled by the level of magnetic flux in the machine. Since the flux level is directly proportional to the field current provided, a control parameter for machine speed is realized. In a similar manner, as shown in Figure G.2.3-2, the armature torque generated is a linear function of the armature current and the flux level. Hence torque control is also realized through this same control parameter. In a system which incorporates a homopolar motor and a generator, both speed and torque control are available to the user.

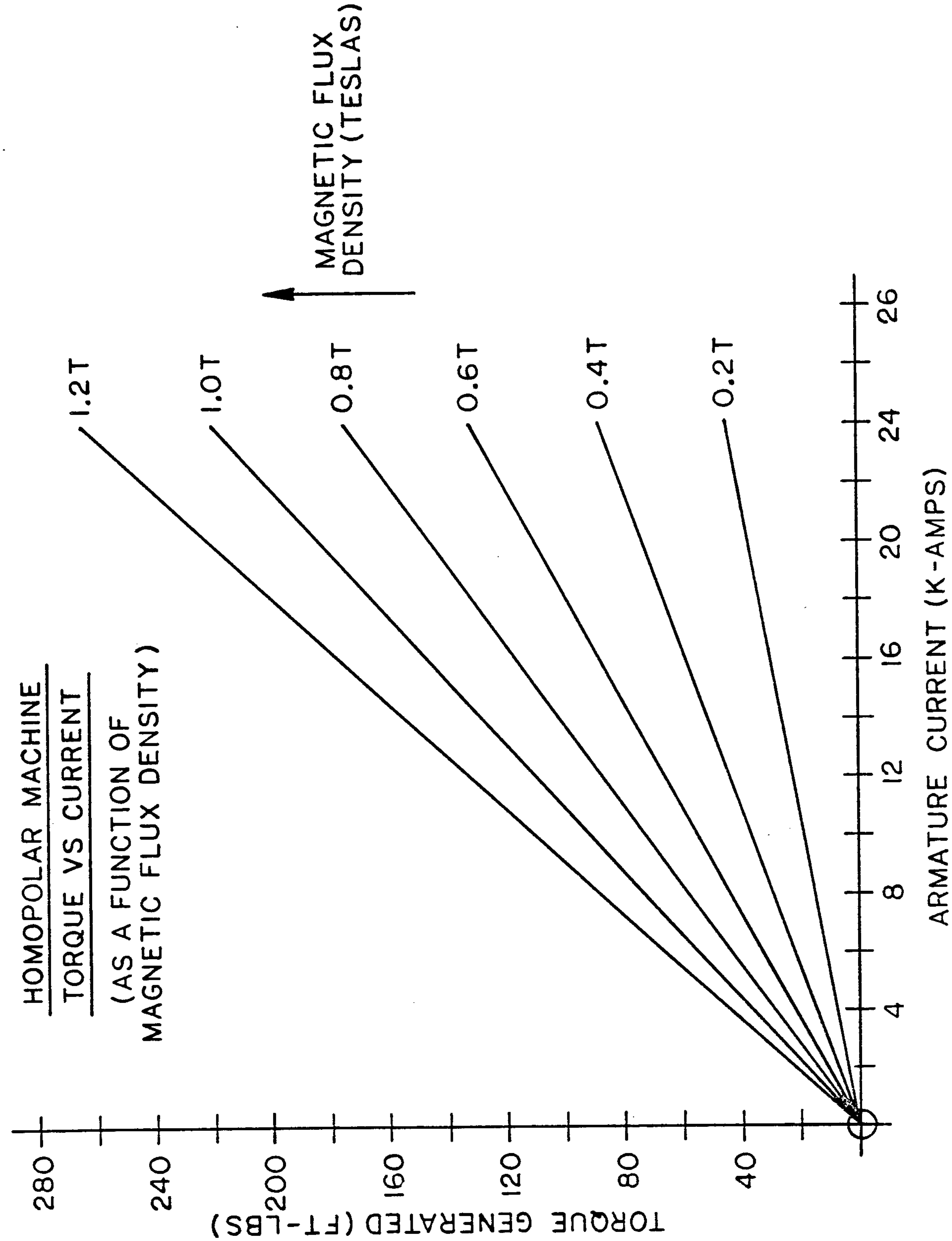
G.2.4 Power Density

Power densities of homopolar machines are moderate in comparison with those of competing technologies. Although significantly better than those of conventinal DC machines or industrial AC induction motors, homopolar power densities are not as great as those of machines excited by high frequency AC (i.e., high frequency synchronous or hybrid, brushless machines). This is due in part to the low induction level of materials available and thus the amount of magnetic material required to carry the necessary flux levels. It should be realized, however, that if the weight and volume requirements of the series controller required by each of the AC systems is incorporated into an overall system weight for each of the alternate technology macines, a more equitable comparison is achieved. In such a comparison the power density of the homopolar system is competitive.

G.2.5 Thermal Requirements

The homopolar machnes recommended for use as vehicle propulsive elements require liquid cooling for proper operation under normal vehicle loads. This is also true for other high performance technologies (i.e., high frequency AC driven machines). Internal cooling of the homopolar machine rotor drum and brush assemblies are flood cooled, and coolant is circulated through each of the field coils. There is no requirement regarding the ion content of the coolant due to the low potentials which exist within the machine. Precautions, however, should be taken to maintain coolant cleanliness consistent with that required by machines of similar precision.


HOMOPOLAR MACHINE
VOLTAGE VS SPEED
(AS A FUNCTION OF MAGNETIC FLUX DENSITY)
MAGNETIC FLUX DENSITY (TESLAS)
1.2T
1.0T
0.8T
0.6T
0.4T
0.2T
VOLTAGE GENERATED (VOLTS)
28
24
20
16
12
8
4
ROTOR VELOCITY (KRPM)
2
4
6
8
10
12
14
16


HOMOPOLAR MACHINE
TORQUE VS CURRENT
(AS A FUNCTION OF MAGNETIC FLUX DENSITY)
MAGNETIC FLUX DENSITY (TESLAS)
1.2T
1.0T
0.8T
0.6T
0.4T
0.2T
280
240
200
160
120
80
40
TORQUE GENERATED (FT-LBS)
4
8
12
16
20
24
26
ARMATURE CURRENT (K-AMPS)

G.2.6. Rotor Inertia

Rotor inertia of drum configured homopolar machines are competitive will all alternate technology machines and in many cases, such as with large diameter brushless motors (LSHT), are significantly better. Rotor magnetic material mass is the primary influence on this parameter due to the requirement of a complete flux circuit path. Several innovative inertia reduction techniques have been proposed which could ultimately reduce homopolar inertias to less that 25 percent of present designs, resulting in extremely responsive high power machines with servo-drive applications.

APPENDIX H

AC MACHINES OPERATION

H.1 General

In this section, induction, synchronous, and permanent magnet machines are briefly described in terms of their operation.

H.2 Induction Motors. Induction motors are probably the most universal of all motors in present use. They are characterized by extreme simplicity, very rugged construction, high reliability, and low manufacturing cost. AC induction motors can be designed to operate over wide frequency extremes and are very tolerant to waveshape (although reasonable sine waves are preferable), and applied voltage variations. They can be easily designed for single, two, or three or more phased operations. While single-phased motors are not easily reversible, three-phased designs can be reversed electrically.

Operation of induction motors is best described by transformer theory. For simple example purposes, the stator winding can be considered as the primary winding and the rotor the secondary winding. However, the rotor winding is essentially a number of parallel, shorted turns. Thus, voltage so induced across the airgap causes a voltage and appropriate current to circulate in the rotor windings. This rotor current produces a reactive force which opposes the stator current, producing rotation of the armature which is attached to the output shaft. The motor/transformer analogy, however, is no longer valid when the airgap is considered. In a well-designed multiphase power transformer, the airgap is made as small as possible to minimize the loss in power conversion from the primary to secondary winding. In the induction motor, the airgap must provide a correct balance of induced flux in the rotor and airgap loss. Due to the series relationship of the motor windings and the airgap, and the low resistance of the rotor windings, large currents flow in the rotor conductors when small voltages are present at the rotor windings. This action directly depends on the voltage and current relationships resulting from application of the turns ratio of the stator and rotor windings.

The motor "series" airgap thus balances the excess voltage flux wave not required by the rotor to maintain the rotating speed. In the transformer analogy, this would be equivalent to a high leakage reactance design with a mechanical separation between primary and secondary windings. In this specific case, the leakage reactance balances the excess flux when the secondary winding is shortcircuited.

So far, the discussion has established the theory of rotation for the armature. For the armature to actually rotate, the airgap flux wave must also rotate, either continuously, as in a three-phase AC system, or instantaneously, as in a single-phase AC system. For single-phase systems, a capacitor or separate start-winding is required to shift the phase of the airgap flux wave to start rotation. However, for electric vehicle use, we will consider only the three-phase power system since the three-phase AC system has a naturally occurring flux field rotation.

The transformer analogy of induction motors can also be extended to the relative size of the motor. The well known transformer equation relating flux density, applied voltage, core area, and frequency (a specific application of Faraday's law) applies directly to AC induction motors. Thus, for low frequency AC systems, the area and volume of stator and rotor iron required to support the applied voltage will be greater than for higher frequencies. Coupled with the naturally rotating flux wave of three-phase systems, this sets the physical dimensions of the motor. It also allows for a convenient control of motor speed by varying the applied frequency, since changing the frequency results in a change in the rotating flux field in the airgap. Generally, industrial induction motors can be operated over a minimum of 2/1 speed range with some operation of up to 4/1.

Electric vehicle application experience using AC induction motors has been favorable. Extensive design and testing of induction motor powered vehicles took place in the early 1970's. The test results were generally satisfactory--the major problem being the reliability of the variable frequency inverter. The development effort did, however, establish desirable characteristics for the induction motor (mainly reduced size and weight, and improved efficiency) for electric vehicle use.

H.3 Synchronous Motors. In the discussion dealing with induction motors, it was established that the rotor reactive force is developed by induced voltage and the resultant current is transformed from the stator winding. As the reactive force creates armature rotation, the actual armature positional relationship with respect to the induced rotor flux will be slightly retarded. As the motor approaches full speed, the positional relationship becomes relatively constant, and thus rotates at a speed equal to 3 to 10 percent of the applied frequency base speed. This difference in rotor speed as a ratio of base speed is defined as the slip speed.

A special case can be made for AC induction motor designs in which the slip ratio is held at unity. Under this circumstance the rotor speed and the field flux rotational speed are equal. Motors of this type thus have a synchronous speed relationship, and bear this name. Synchronous motors are characterized by having wound rotors which can be separately excited from an external voltage source, rather than excited through induction from the stator winding. This capability allows for establishing a high reactive force in the armature, even at zero rotor speed. It holds that the stator induced field flux and the rotor reactive force developed from separate power can be individually controlled. Since the rotor reactive force determines the motor torque and the stator frequncy controls the motor speed, the synchronous motor has the inherent characteristics desirable for electric vehicle applications. An additional control characteristic is available in synchronous motors because of slip frequency. Since by definition, synchronous operation requires that the slip frequency be unity, a change in slip frequency requires a corresponding in rotor speed to maintain the motor magnetic circuit in balance. In synchronous motors, the slip ratio can be controlled by a change in the rotor

excitation. Thus for electric vehicle applications, either the stator frequency or rotor excitation may be changed to command acceleration or deceleration, as required.

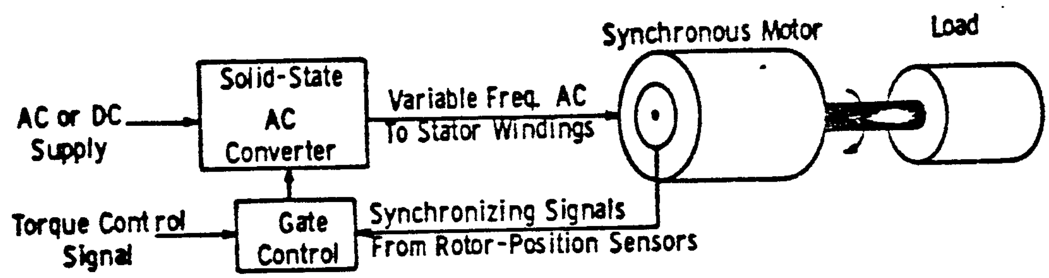
Recent developments in synchronous motors and generators have eliminated the requirement for direct excitation connections to the rotor windings. Figure H.3-1 illustrates the system for controlling the rotor excitation by additional components attached to the common output shaft. The key feature of this system is the integral AC exciter/alternator and rotating rectifiers. This system can produce the required rotor excitation very efficiently due to the transformation action of the alternator. System controlability is excellent due to the high gain available in the control loop. Due to the transformation characteristics of the AC exciter, small, low-power error signals can command the motor/generator system over the full-rated power range. Response times are very short and thus the system is very reactive to operator inputs. This command/control characteristic is desirable in electric vehicle drive systems to maintain both responsiveness and stability.

H.4 Permanent Magnet Brushless DC Motors. During the mid-1950's, development of high energy magnet materials allowed designers to employ these permanent magnets in motor structures as the source of rotor excitation. As permanent magnet materials have improved, designers have applied them to larger motors which at present range up to 50-100 Horsepower. Early development of the permanent magnet motor was characterized by simply substituting the magnet for a wound-field structure in shunt-wound DC motors. The motor thus performed in a similar fashion to the conventional, DC mechanically-commutated motor, except that motor speed increased linearly with applied voltage. This characteristic is due to the fixed, constant-level of field flux generated by the permanent magnets.

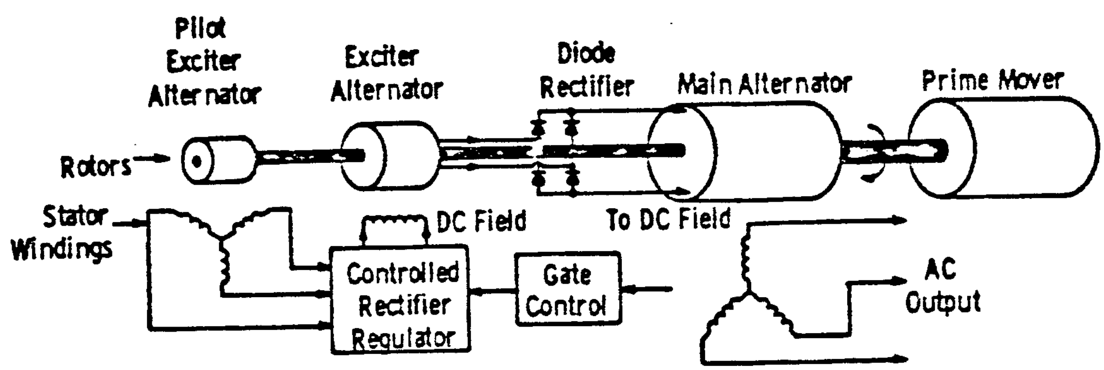
While the speed versus applied voltage linearity was recognized as a desirable characteristic, the speed versus torque curve reacts in an opposite manner. Thus, while speed increases with voltage, torque decreases with speed in a reasonably linear fashion. These features of the permanent magnet motor, while usable in many applications--including small electric vehicle drives, would not be sucessful in large electric vehicle drives where extreme performance is the requirement.

Within the past ten years, development efforts in permanent magnet motors have produced a true hybrid motor. These hybrid motors have many of the desirable characteristics of DC motors (such as speed versus voltage linearity) while being controlled and commutated from an AC source. This family is generally labeled "Brushless" DC motors.

Brushless DC motors are characterized by their construction which is similar to a conventional multiphase AC motor, except the usual peripheral field permanent magnets are replaced by a multiphase (usually three) winding powered by an electronic inverter. The inverter is operated at selected frequencies which are dependent on motor design and provide the electronic commutation function. The permanent magnets are attached to the rotor in a manner which



(a) High Frequency AC Synchronous Motor Drive



(b) High Frequency AC Synchronous Alternator

Figure H.3-1. Diagrammatic Representation of Brushless Excitation System

provides for field flux in the stator/rotor airgap. This design allows for considerable flexibility in the rotor design and the number of poles available for reacting with the rotor. These design variables result in two basic brushless motor designs: one having small rotor diameters, few poles, and a magnet length dependent upon the horsepower requirement; and one having large rotor diameters many poles and, relatively short magnet length. Generally these two motor types are classified as High Speed/Low Torque (HSLT), and Low Speed/High Torque (LSHT) designs.

Excellent thermal characteristics is one of the major features of the brushless motor design. With the heat-generating windings situated on the stator, low thermal resistance in the stator iron allows for relatively unimpeded heat flow to the outside motor shell. Appropriate cooling can be employed to removed this heat and maintain the motor at rated temperature. Very little heat is generated by the permanent magnet rotor structure and, consequently, the rotor temperature rise is minimized.

General reliability of brushless motors is very favorable. Care must be used in selecting the motor type, however, so that vibration and shock do not cause damage to the magnet structures. Although minor cracking of the magnets will not cause a major motor failure, cracks can cause degradation in motor performance. A more significant failure can result if the magnets fragment and produce chips which can lodge in the airgap.

Brushless DC motors offer desirable features to electric vehicle drives. The control characteristics, when considered with the capabilities of electronic commutation controllers, offer the potential for independent speed and torque control. Motor efficiency is high and the construction provides excellent thermal dissipation. Further, as defined by the vehicle specifications, the brushless motor may be designed for high- or low-speed operation with the appropriate resultant torques.

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